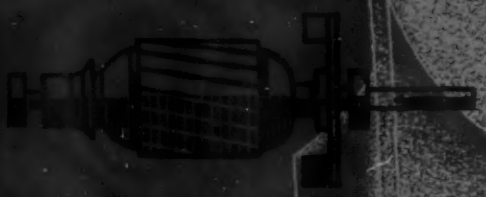
POWER TRANSMISSION DESIGN

Special Preview: Design Engineering Show

OEM · · MAINTENANCE

MAY 1959



Higher Operating Speeds Are Coming.....

Flexible Shafts Power Ball Screw Jacks

Twin Engines Cut Size/hp Ratio

G-g Sets Control Bulk Handling Process

Facts About Air-Lubricated Bearings

THE MAGAZINE OF MACHINE DRIVES

News and ideas for designers and plant engineers who use power drive equipment

PEAK POWER OUTPUT FOR HEAVY-DUTY EQUIPMENT...

HYDRA-DRIVES®

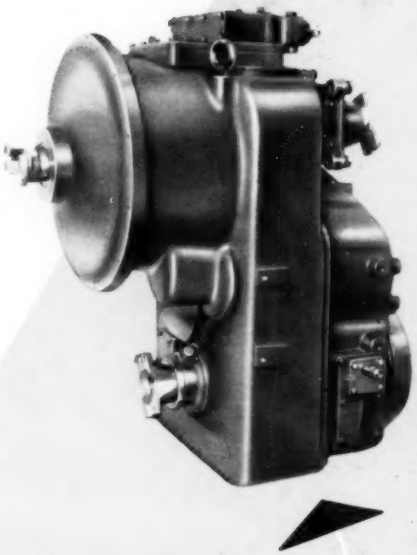
POWER SHIFT TRANSMISSIONS and TORQUE CONVERTERS

Rockwell-Standard's Hydra-Drives units make hard work easy for heavy-duty equipment. The result . . . smooth, efficient, economical operation. A torque converter and 4-speed transmission in one compact package, the Hydra-Drives Power Shift Transmissions have been proved in hundreds of vehicles. They eliminate engine lugging and heavy shock loads. A 3-to-1 torque multiplication makes starting fast and effortless—even with heaviest loads.

Just a flip of the operator's lever accomplishes power shifts without interruption of the power flow. Automatic features of the converter and ease of power shifting simplifies operator training and lengthens vehicle life.

With four speeds forward and reverse, the Hydra-Drives Power Shift Transmissions are ideally suited for vehicles which must travel in both directions during a normal work cycle.

Hydra-Drives Torque Converters are the simplest, most efficient made. They can be matched with any transmission for easier, more efficient operation.



HYDRA-DRIVES BDB Transmission

- Four speeds forward and reverse.
- Full power shifting.
- For equipment up to 175 h.p.

HYDRA-DRIVES CDB Transmission

- Four speeds forward and reverse.
- Power shift in each range both forward and reverse.
- For equipment up to 250 h.p.

HYDRA-DRIVES Torque Converter

- 3-to-1 torque multiplication.
- Available separately, or with Hydra-Drives Transmission.
- For vehicles up to 500 h.p.

HYDRA DRIVES

ROCKWELL-STANDARD CORPORATION
TRANSMISSION AND AXLE DIVISION
DETROIT 32, MICHIGAN

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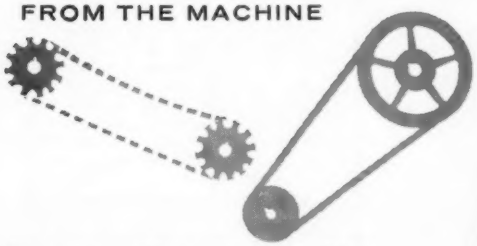
Products of **ROCKWELL-STANDARD** Corporation

For more information circle No. 25 on the Reader Service Card

maurey DRIVES

get full power
OUT OF THE MOTOR

full production
FROM THE MACHINE

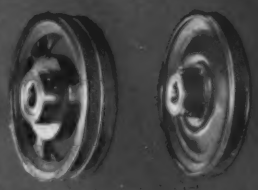


Before any machine puts out, a drive has to put power in, and that's what Maurey Drives do with maximum effectiveness. Maurey V-Drives and Roller Chain Drives are engineered to get full power from the motor to the point of production. A Maurey power transmission specialist will help you get the right drive on the job for almost any situation . . . the stop and go of a refrigeration drive, the smooth power flow of a textile drive, the pulsation of a rock crusher drive, or the round-the-clock action of an oil drilling drive.

Call your local Maurey Drive distributor, or write for any one or all of these Maurey Power Transmission Catalogs:

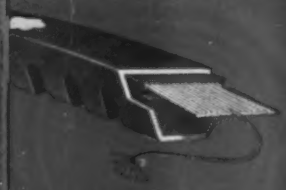
- FHP V-Drive Catalog F-10
- V-Belt Catalog No. 55
- Multiple V-Drive Catalog, MVD-58
- Maureymatic Variable Speed Transmission Catalog No. MM-58
- V-Drive Engineering Manual
- Roller Chain Drive Catalog D-58
- Conveyor Pulley Catalog CV-1

maurey...
the complete, *engineered* drive line



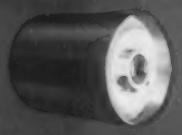
Hi-Q FHP V-Pulleys

FUL-GRIP Q-D Sheaves



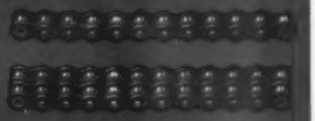
Mor-Grip Green Seal V-Belts

Maureymatic
Variable Speed Transmissions



Conveyor Pulleys

Sprockets



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And a complete line
of Drive Accessories

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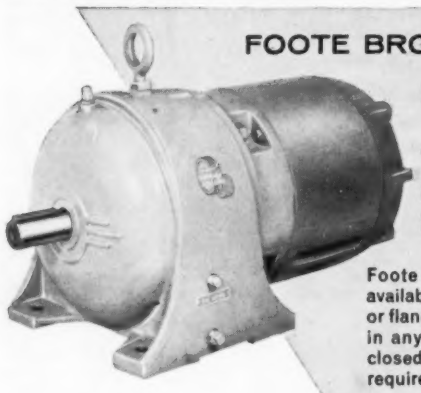
FOOTE BROS. **Motorized Drives**

Duti-Rated LIFETIME GEARING

Gives You More Power Per Dollar



FOOTE BROS.-LOUIS ALLIS

GEARMOTORS

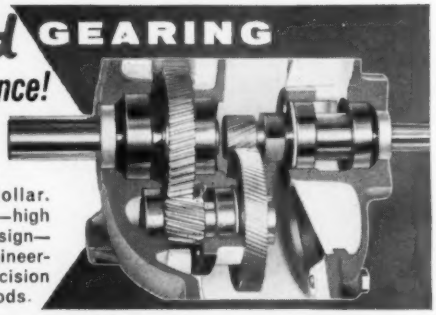
1 to 150 HP...Single, Double, Triple, Quadruple Reductions . . . Output Speeds from 780 to 7.5 RPM

Foote Bros.-Louis Allis Gearmotors are available in over 3500 types and sizes. Foot or flange mountings. Motors can be ordered in any type—open drip-proof, totally enclosed, explosion proof, etc. to meet your requirements.

Duti-Rated GEARING

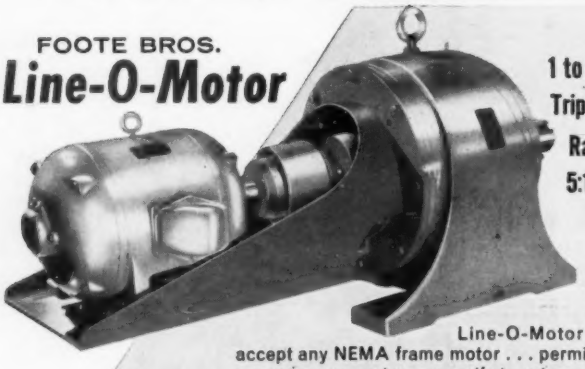
Makes the Difference!

Duti-Rated Gearing is the heart of Foote Bros. Motorized Drives . . . drives that give you more load capacity and wear life per dollar. This is premium quality gearing—high hardness, accurate, balanced design—the product of thousands of engineering and development hours, precision tooling and manufacturing methods.



FOOTE BROS.

Line-O-Motor



1 to 75 HP...Double, Triple Reductions... Ratios: 5:1 thru 238:1

Line-O-Motor Drives accept any NEMA frame motor . . . permit you to use your own motor or specify type to meet plant standardization. Foot or flange mounted.

Write for CATALOG MRA. It has complete details and selection data on Foote Bros. Motorized Drives.

100 YEARS SERVING INDUSTRY 1859-1959

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION

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POWER TRANSMISSION DESIGN

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THERE'S POSITIVELY
NOTHING LIKE NEW GOODYEAR

positive drive

BELTS

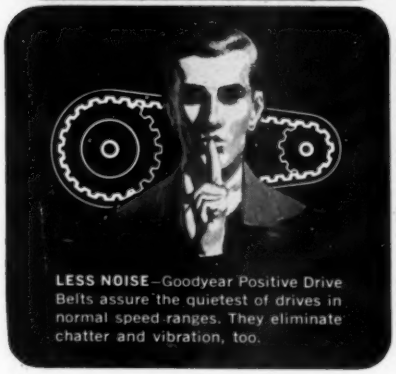
–for positive assurance of quality in maximum-efficiency belts

With Goodyear quality Positive Drive Belts now at your disposal, you're free to explore all these new avenues in machine or appliance design –

SMALLER SIZE–With Goodyear Positive Drive Belts, you can use smaller pulleys – shorter centers – narrower belts of higher capacities. Center distance can be permanently established.

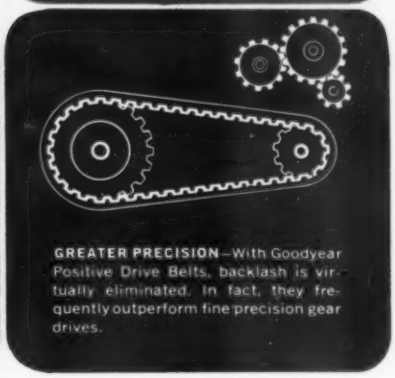
LIGHTER WEIGHT – With their high horsepower-to-weight ratio, Goodyear Positive Drive Belts are ideal for portable tools, machines and aircraft assemblies. Pulleys can be light plastics or alloys.

LIGHTER BEARINGS – Since the use of Goodyear Positive Drive Belts makes high tension no longer necessary, bearing loads are much less. Some bearings as well as adjustable motor bases and idlers may be elimi-



LESS NOISE–Goodyear Positive Drive Belts assure the quietest of drives in normal speed ranges. They eliminate chatter and vibration, too.

SIMPLIFIED MAINTENANCE – Since Goodyear Positive Drive Belts involve no metal-to-metal contact, no lubricating systems, oil-retaining devices, etc., are necessary. That bars possible product contamination, too.



GREATER PRECISION–With Goodyear Positive Drive Belts, backlash is virtually eliminated. In fact, they frequently outperform fine precision gear drives.

And remember – Positive Drive Belts are designed and built to the famed Goodyear high standards of quality. For full details on belts for drives from fractional to 600 H.P.–for speeds up to 16,000 f.p.m., contact the G.T.M. – Goodyear Technical Man. He's available through your Goodyear Distributor – or by writing Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.

Goodyear Positive Drive Belts are manufactured under license and according to U. S. Patents 2,507,852 and 2,397,312.

POSITIVE DRIVE BELTS BY

GOODYEAR

THE GREATEST NAME IN RUBBER

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May 1959, *volume 1 number 5*

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FACTS

and figures on products and literature of interest to designers, engineers, and other power transmission design people can be had by circling the right numbers on the reader service cards found opposite page 56.

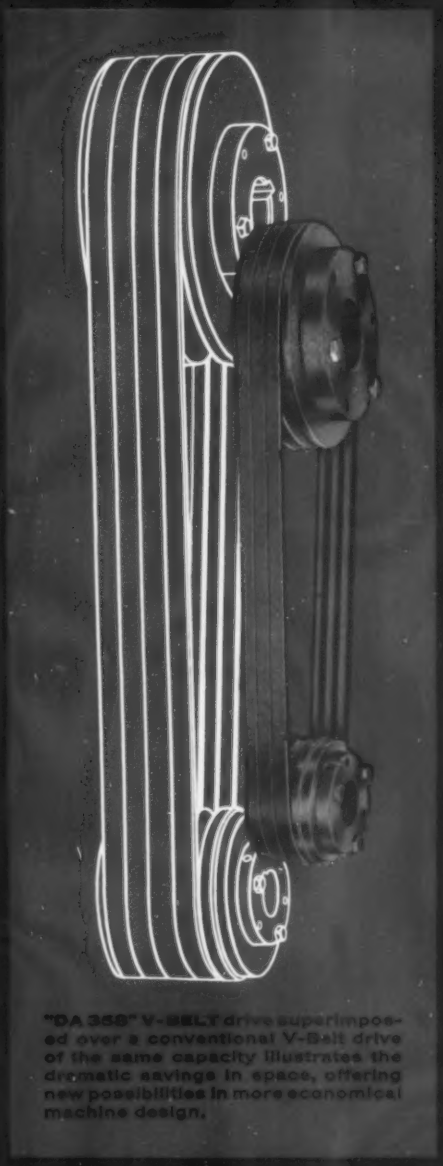
Now . . . from Durkee-Atwood

DA 358 V-BELTS

Introducing the entirely new V-Belt concept for compact, Plus-Power Drives

From Durkee-Atwood, pioneer manufacturer of high quality V-Belts for industry, comes the great new "DA 358" V-Belt, opening up completely new opportunities for highly compact, economical multiple V-Belt drives. "DA 358" V-Belts are engineered for unprecedented power transmission as compared with conventional V-Belts . . . with the ability to transmit more horsepower in a given area, at less cost, and with fewer belts, smaller, lighter sheaves and shorter center distances. They are manufactured with the quality and precision for which Durkee-Atwood is famous—quality which *we invite you to test.* Manufactured in 3V, 5V and 8V sizes.

SPECIAL: Durkee-Atwood's new "Red Shield" V-Belts now have a ***horsepower rating 40 per cent higher than former Standard V-Belts***—part of a major V-Belt upgrading program for improved drive design.



"DA 358" V-BELT drive superimposed over a conventional V-Belt drive of the same capacity illustrates the dramatic savings in space, offering new possibilities in more economical machine design.

We invite you to test DA 358 V-Belt against all other V-Belts

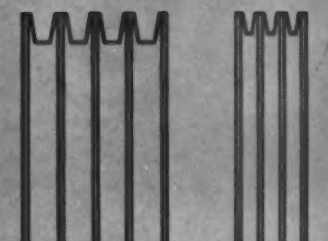
Write on your letterhead giving data, and we will forward to you our engineering recommendations.

Write

DURKEE-ATWOOD COMPANY

MINNEAPOLIS 13, MINNESOTA

Look for the DA *on your V-Belts*



SHEAVE WIDTHS are sharply reduced with a "DA 358" V-Belt drive. Figure at left shows sheave width for a conventional drive. Figure at right is sheave width for a comparable "DA 358" V-Belt drive.

For more information circle No. 10 on the Reader Service Card

US ROYAL V-BELTS

THE NEW, ALL-NEW U. S. ROYAL V-BELT

NEW *all new* because its cords are treated by an entirely new automation process. Every cord is impregnated with latex in every fiber (not merely surface-coated). Every cord is then built into the belt under tension, with errorproof electronic precision to insure that each will pull its uniform share of the load.

NEW *all new* because the belt is cured by a unique method of molding developed by U. S. Rubber. Consequently there can be no inner or outer imperfections, no harsh bumps. This means smooth-running performance, long belt life.

NEW *all new* because the new covers of new fabrics become a homogeneous blend through new molding techniques. This results in longer belt life by increasing wear resistance.

NEW *all new* because this new method of construction results in strength to spare... a reserve of strength which combined with vibration-free running, results in greater drive efficiency.

NEW *all new* because U. S. Royal V-Belts feature perfect matchability. Born matched, they stay matched.

U.S. Royal V-Belts are in stock at all "U.S." Transmission Distributors. • • •

When you think of rubber, think of your "U.S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

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All these advantages built into the new U. S. ROYAL V-BELT increase H. P.

40%

NO PREMIUM PRICE

The new cords and new fabrics and new construction methods all add up to increasing the H.P. rating of U. S. Royal V-Belts by 40%. These superior improvements mean higher drive capacity at less cost. Using fewer belts and narrower sheaves means less belt cost and less sheave cost. Yet, with all this, you pay no premium for the new U. S. Royal V-Belt!

LETTERS

Address letters to:
The Editor
Power Transmission Design
812 Huron Road, Cleveland 15, Ohio

Gentlemen:

It was good to see a story about dry fluid drives in your March issue. It was very good, and I'd like to get copies of the pictures for our files if you can release them or let us know whom to contact. Apparently you have an editorial policy against the use of trade names like Flexidyne. Doesn't that make it unnecessarily difficult for your readers to trace the source of a product to solve a similar problem? However, your magazine continues to reflect the careful planning that went into it.

CARLTON SHAMO
Dodge Manufacturing Corp.
Mishawaka, Indiana

Gentlemen:

Have just finished reading my second edition of your POWER TRANSMISSION DESIGN magazine. A magazine covering the power transmission field exclusively has certainly been needed for many years. POWER TRANSMISSION DESIGN is filling this need in an excellent manner. Keep up the good work.

R. T. DUDLEY
Sales Manager
The Imperial Electric Company
Akron, Ohio

Gentlemen:

I would like . . . to express my appreciation of your new magazine. I spent a very pleasant two-hour train trip recently reading and studying issue number two. The articles were most interesting, the layout excellent, and I too cast my vote for the perforated pages. Much success to you and your staff.

F. D. WISE
Clark Equipment Co.
Buchanan, Mich.

MEN *of the power transmission field*

Timken Sales makes executive changes

SALVAGE

REEVES

WINGERTER

PETERSON

COVEY

Paul J. Reeves is new vice president in charge of sales for the Timken Roller Bearing Co., Canton, Ohio, succeeding W. B. Moore, who retired. He joined the company 30 years ago as a sales engineer, became district manager of the Industrial Div.'s California branch in 1932, sales promotion manager in 1940, manager of the Priorities Dept. in 1941, advertising manager in 1944, and director of sales in 1951.

To fill vacancies created by his promotion, these changes in the Sales Div. have been made: Robert G. Wingerter, director of sales; S. T. Salvage, general manager of the Automotive Div.; Norman H. Peterson, advertising manager; and W. Roderic Covey, assistant advertising manager.

Wingerter came to Timken in 1938 as a sales trainee in the Industrial Div. in Canton. He became an industrial engineer two years later, assistant chief engineer of the division in 1943, sales engineer, Automotive Div. in Detroit in 1944, assistant general manager in 1951 and general manager in 1955.

Salvage joined the company in 1933 as a sales engineering trainee, became a sales engineer in the Industrial Sales Div.'s Pittsburgh office a year later, transferred to the Houston office in 1937, and was named district manager of the Los Angeles office three years later. He entered the Navy in 1943, returning to Timken in 1945 as assistant district manager of the Cleveland office. In 1949 he became sales promotion manager for the Industrial Div., advancing to advertising manager in 1951.

Peterson joined the company in 1946 as a copywriter, was promoted to assistant advertising manager in 1951, a position he held until his recent promotion.

Covey had been a copywriter for the advertising dept. since 1957, until his recent promotion. Before that he had been with the Timken magazine since 1952, as editor since 1955.

Changes at Manhattan Rubber

Following retirement of John H. Matthews as executive vice president of Raybestos-Manhattan's Manhattan Rubber Div., Passaic, the following changes have been announced:

Joseph N. Kuzmick becomes divisional manager, moving up from coordinator of corporation research and development. He has been with Manhattan since 1919, and has been active in the development of brake linings and sintered metal friction products, among other things.

Clarence P. Schneider has been promoted to assistant to the divisional manager. He had been general manager, and before that factory manager, of the Wabash Div., at Crawfordsville, Ind. Before coming to Wabash, he was assistant manager of the Friction Material Dept., Passaic.

Two new manufacturing general managers have been named: Robert J. Gorecki, and Wilder E. Perkins.

Airflex names Sales Manager

MACK

Raymond E. Mack, Jr., has been named sales manager of the Airflex Div. of the Fawick Corp., Cleveland. He will be responsible for sales of the company's air-operated clutches and brakes to industry. He had been a sales engineer with Fawick's New York representative, the Edwin J. Montalvo Co., since 1952. Before that he was a sales service engineer with IBM.

Lord opens new field office

BERGESON

Lord Manufacturing Co. has opened a new field engineering office, in San Francisco, to be managed by R. M. Bergeson. He had been a field engineer in the company's Los Angeles office, responsible for Washington, Oregon and part of California, for the last two years.

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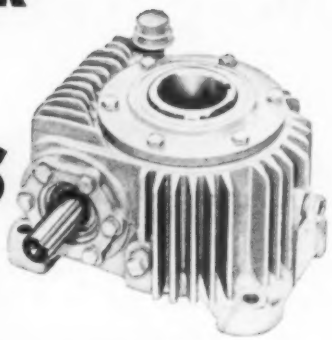
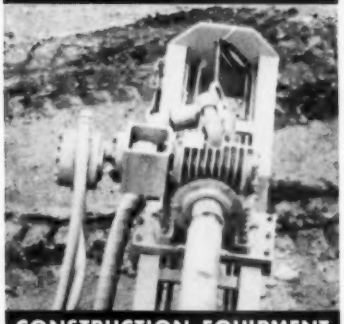
CONE-DRIVE WORM GEAR HOLLOW SHAFT SPEED REDUCERS

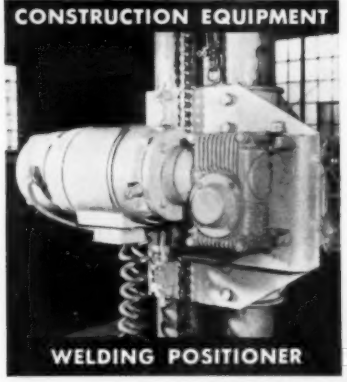


provide greater flexibility in the design of your equipment

MIXING MACHINE



CONSTRUCTION EQUIPMENT



WELDING POSITIONER

Standard Cone-Drive hollow shaft speed reducers are available in four basic sizes (2, 2½, 3 and 3½ inch center distance units) to accommodate loads from fractional to 13 horsepower. They are built around the double-enveloping worm gear design and carry the same high ratings as standard Cone-Drive speed reducers.

You, as a designer, will be particularly interested in the versatility of application and space savings made possible by the right angle design between input and output shafts.

The reducer is mounted directly on the driven shaft and requires only a simple bracket or torque arm to prevent it from rotating about the driven shaft.

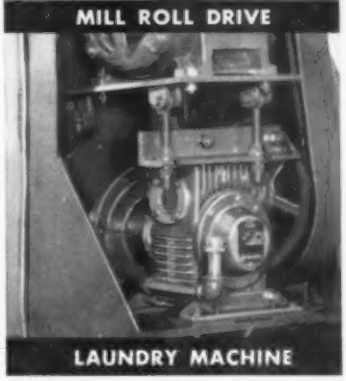
Construction is rugged enough to permit floor or wall mounting of Cone-Drive hollow shaft reducers and "hanging" the driven shaft on it (in certain applications), eliminating pillow blocks or bearings. Larger-than-necessary taper roller bearings and heavy-duty castings make this possible.

If a motorized reducer is desired, a simple, standard bell housing can be furnished for NEMA C-type face motors. The need for expensive couplings is eliminated since a tang-type drive sleeve and suitably machined worms are provided. When a hollow-shaft speed reducer and face-mounted motor are combined, no bed plate or mounting arrangement is required. Pulleys, belts, sheaves, etc., that might be troublesome or difficult to install are also eliminated.

Ask for Bulletin CD-218.

TROLLEY HOIST

MILL ROLL DRIVE



LAUNDRY MACHINE

CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

7171 E. McNichols Road • Detroit 12, Michigan • Telephone: TWinbrook 1-3111

DOUBLE-ENVELOPING WORM GEARSETS | DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS | DOUBLE REDUCTION WORM GEAR SPEED REDUCERS | DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

For more information circle No. 8 on the Reader Service Card

Working on any of these design improvements

RELATED TO TORQUE TRANSMISSION? .... *more capacity*

greater angles

no torsional vibration

higher speeds

longer shaft life

extended bearing wear

If so, and if your application warrants placing the solution and ultimate cost-savings above ordinary, lower priced joint designs . . . RZEPPA can help you. Here's why:

By transmitting a uniform flow of power through ball bearing action, RZEPPA *Joints operate with less friction; carry heavier loads and are more compact than any other type of joint . . . size for size.*

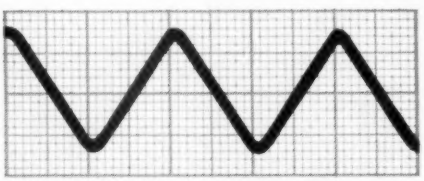
RZEPPA Constant Velocity Joints are available for *light, medium* and *heavy* duty on air and space craft, vehicles and industrial machinery.

WRITE FOR LATEST LITERATURE or send your dimensional sketch with peak horsepower, R.P.M. and operating angles. Without obligation, our engineers will assist you. Address: THE GEAR GRINDING MACHINE COMPANY, Dept. TJ-559, 3901 Christopher St., Detroit 11, Michigan.

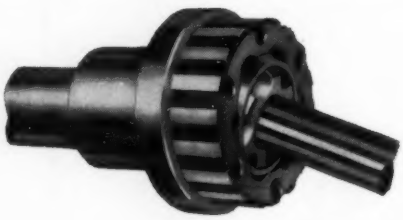
RZEPPA CONSTANT VELOCITY UNIVERSAL JOINTS

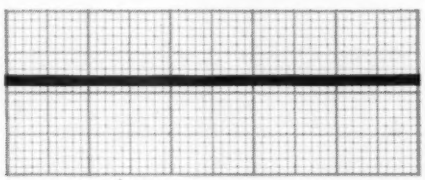
(PRONOUNCED: "SHEPPA")

Genuine RZEPPA Joints are made exclusively by THE GEAR GRINDING MACHINE CO.



ORDINARY CROSS OR PIN UNIVERSAL JOINT — Mathematics and geometry prove this joint changes velocity of the driven shaft with two high points and two low points per complete revolution. This fluctuating torque action causes vibration and wear throughout entire driving mechanism.





CONSTANT VELOCITY JOINT — This RZEPPA design joint *always* transmits smooth torque even at unbalanced angles. Such smooth torque action results from ball bearings applying power in a plane that bisects both shaft axes.

For more information circle No. 15 on the Reader Service Card

Crofts Patented Roller-operated Disc Friction Clutches

CROFTS 'RO'

A fine general purpose roller-operated single or double disc clutch. Ideal for a wide range of industrial drives. Fourteen sizes to transmit powers from fractional to 320 h.p. at 100 r.p.m., for shaft sizes from ¾" to 7" diameter.

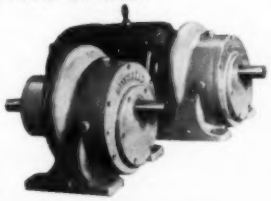
CROFTS 'RM'

A high-precision multiple disc clutch, ideal for machine tools and special machines, especially where space is limited. Designs available to run dry, or under oil spray, or immersed in oil. Eight sizes to transmit powers fractional to 15 h.p. at 100 r.p.m., for shaft sizes ¾" to 4" diameter.

made of course by

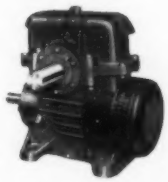
CROFTS ALSO MAKE:

"Ritespeed" Motorized Conveyor Pulleys; all driving mechanism housed inside the Pulley itself.



Worm Gearmotors

Slipping Couplings



"Ritespeed" Gears and Gearmotors

THE WORLD'S FINEST INDUSTRIAL FRICTION CLUTCHES . . .

Crofts

RO & RM Clutches can be run at high or low speeds and in either direction of rotation, unaffected by centrifugal forces. Engagement or disengagement is easy at any speed. Clutch can be operated for long periods either engaged or disengaged. No 'thrust' when engaged.

CROFTS U.S.A. INC.

POWER TRANSMISSION ENGINEERS

2542 West Peterson Avenue, Chicago 45, Illinois

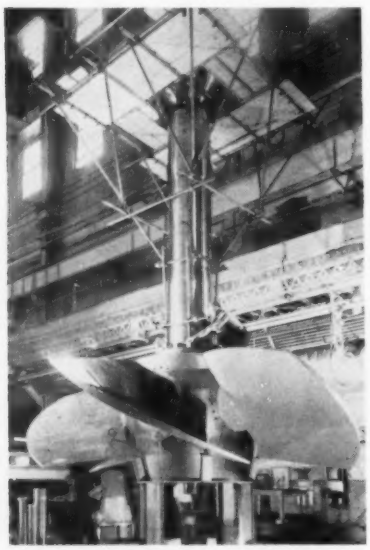
EASTERN STATES DISTRIBUTORS:
Rockwood Pulley Mfg. Co., Inc., 20 Crosby St., New York 13

For more information circle No. 9 on the Reader Service Card

NEMA says foreign equipment buying threatens security

WASHINGTON—Joseph F. Miller, managing director, National Electrical Manufacturers Association, recently told a press conference here that "since 1953 a very substantial proportion of the purchases of heavy electric power equipment by Federal agencies has come from overseas sources. This rapidly growing dependence on foreign sources," he said, "threatens this nation's ability to maintain adequate and continuous supply of electric power in time of national emergency."

Equipment referred to by Mr. Miller consists of hydraulic turbines and other large electrical generating and distribution equipment. The equipment is purchased by such de-



LARGE PROPELLOR TURBINE to deliver 34,000 horsepower is typical of large electrical generating equipment being purchased by U. S. agencies from foreign manufacturers.

fense-important government agencies as Bonneville Power Administration, Tennessee Valley Authority, and equipment destined for use by the Atomic Energy Commission.

U. S. producers of this equipment, represented on the National Security Committee of NEMA, and the General Electric Co. have filed petitions with the Director of Civil and Defense Mobilization calling for restriction of foreign purchase of four classes of heavy power apparatus. The OCDM is required to act under the Trade Agreements Extension Act of 1958 on any articles that are being imported "in such quantities or under such circumstances" as to threaten national security.

Reasons for this action is that in the event of war, large power generating and distribution equipment would be a prime target of the enemy, and wartime conditions could prevent procurement of parts or equipment, necessary to restore damaged equipment to service, from the overseas manufacturers. During World War II, this did happen in central American countries using German equipment. Another consideration is the maintenance of U. S. facilities for construction and repair of this type of equipment. Domestic manufacturers will not be able to maintain their facilities if too much of this business goes to overseas companies, according to Mr. Miller.

Thrust bearing sails through 20,000 hr on ferry drive

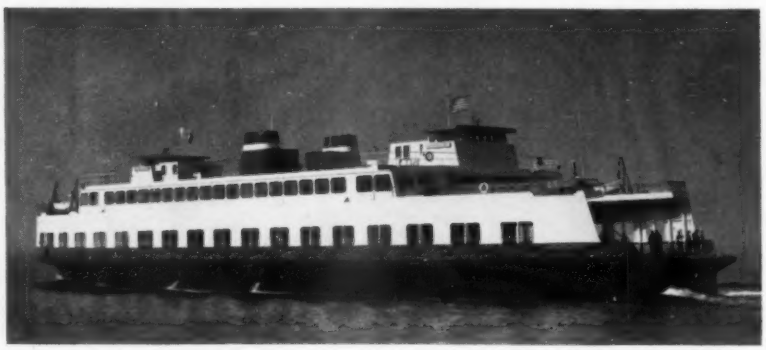
Twenty-thousand hours with no breakdowns and no need for bearing adjustment. That's the record a set of self-aligning thrust bearings has racked up on the *Evergreen State*, a busy ferry of the Washington State ferry system. Installed on the low-speed shafts of the ferry's propulsion units, these bearings have enabled the ferry to make thirteen 19-mile round-trips a day, every day, for more than four years. Not one scheduled trip had to be missed during all that time.

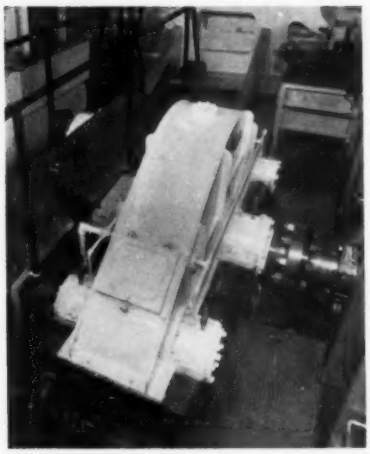
The *Evergreen State*, a double-ended boat 310 ft long, has two propulsion units, each equipped with a special double-acting thrust bearing to carry the propeller thrust. Depending on which direction the boat is traveling, 90 percent of the electric power output is fed to the forward wheel and 10 percent of the aft wheel. The propulsion units at each end consist of twin 1500-hp dc motors, converted for ferry duty from the destroyer USS Mitchell. The motors drive 10½-ft propellors through a double-pinion 600/180 rpm reduction gear (3.341:1 ratio).

The special thrust bearings are designed to handle the shaft's 70,000-lb thrust loads, but they have a safety factor of 2, giving them a capacity at 180 rpm of 158,000 lb and enabling them to meet extremely severe conditions where misalignment and heavy thrust loads in either direction may be present.

Each bearing consists of a center plate, two roller assemblies, left- and right-hand thrust plates with convex spherical face, two matching concave aligning plates, bronze liners, and left-hand spacer sleeve. The bearing

DOUBLE-ENDED FERRY, the *Evergreen State*, has travelled 250,000 miles between Seattle and Winslow, Wash. with no drive trouble.





FERRY'S POWERPLANT consists of two 1500-hp Westinghouse motors at each end, driving propellor through double-pinion reduction gear. Rollway thrust bearing on low-speed shaft handles 70,000-lb thrust loads with a safety factor of 2.

OD 16-7/8 in. and overall width is 8 in. The bearing assembly weighs 296 lb.

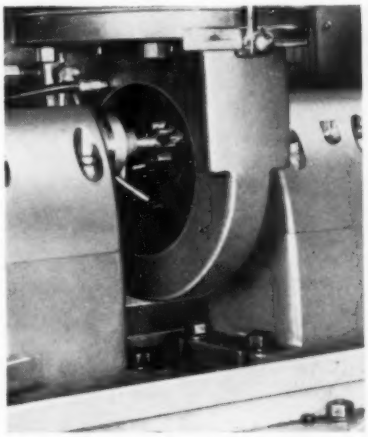
The propeller thrust is carried at right angles to the roll axis on multiple, straight cylindrical rollers. Machined bronze retainers contain three 1-in.-dia. rollers in each of 26 slots. Rollers, of SAE-52100 steel, are hardened to 59-63 Rockwell C, and can withstand operating temperatures to about 300 F. The rollers are compactly secured by a heavy steel band enclosing the retainer's outer edge.

The hardened alloy steel center plate of the Type DAT Rollway bearing is unusually thick—2 in.—to resist deflection. The bore of the revolving center plate is ground for slip fit on the 8-in.-dia propeller shaft, with from 0.0005 to 0.0025-in. clearance. The inner spaced sleeve and center plate are both keyed to the shaft to maintain positive rotation under all conditions. The spacer sleeve, secured by a locknut, provides proper operating float. The stationary thrust plates are bushed with bronze liners to maintain alignment when the thrust load is relieved.

New gear cutter produces gears with 12-tooth (or less)

DETROIT—A new rotary gear shaving process that gives accurate control of surface finish, lead, and profile on gears with 12 or less teeth has been developed and applied successfully by engineers at National Broach and Machine Co. The process gives accuracy not possible with conventional methods using external-gear-type cutters.

An unusual rotary gear-shaving cutter made in the form of an external gear is used. This increases surface contact between the cutter and gear being shaved to produce smoother, more accurate tooth profiles on gears with few teeth. The work gear drives the cutter in this process. Usually, the cutter drives the work gear.



INERTIAL GEAR CUTTER improves accuracy of gears with 12 or fewer teeth.

Meier Transmission is now incorporated

CLEVELAND—Name change to Meier Transmission, Inc., is now official, according to an announcement by Walter F. Meier, head of the firm.

Formerly known as The Meier Transmission Supply Co., the incorporation and name switch took place early in March of this year. The firm is authorized stocking dealer for: Allis Chalmers, Airborne Accessories Corp., American Blower Corp., Cincinnati Rubber Mfg., George P. Dorris Co., Drive-All Mfg., Equipment Engineering Co., Falk Corp., Federal Electric Products, Globe Woven Belting, Jakes Foundry, Jeffrey Mfg., Reliance Electric and Engineering, Stephans-Adamson, Sier-Bath Gear and Pump, Twin Disc Clutch Co., Union Gear and Machine, U. S. Electrical Motors Inc., Whitney Chain, and the Winfield H. Smith Corp.

THIS MUST BE A

Janette

SALES ENGINEER

You may have seen him . . . His name is Jim. Been selling JANETTE SPEED REDUCERS for years.

Customers like Jim. He helps solve their problems quickly. No SPEED REDUCER Power Transmission Problem is too complicated.

Jim is a typical JANETTE salesman. And confident too . . . Because he knows his products are backed up by JANETTE'S competent Engineering Department and modern manufacturing facilities . . . that deliver trouble-free products . . . competitively priced . . . and efficiently designed.

Call on your JANETTE Sales Engineer today. Talk to a man who thinks on his feet.

Janette GEAR MOTORS SPEED REDUCERS

JANETTE—Morton Grove, Ill.
A subsidiary of Victor Adding Machine Co.

Circle No. 20 on Reader Service Card

NEW HIGHER PERFORMANCE FOR FORMCHROME* SPRAGS

On over-running clutch applications, Formsprag clutches have always provided greatest torque capacity for size and weight, no measurable backlash, extreme precision and long trouble-free life. Now! With newly designed Formchrome sprags, the best over-running clutches provide users with even higher performance.

Here's why! The new Formchrome sprags are made of hardened high carbon alloy steel with chromium diffused into the surface to form a chromium-carbide alloy. Thus, the sprag is corrosion resistant, and has high hardness and abrasion resistance similar to tungsten carbides. Result—sprag geometry is retained over a longer period and clutches can be used on higher over-running speeds. The Formchrome sprag is exclusive with Formsprag—no other clutch manufacturer can offer you its performance advantages.

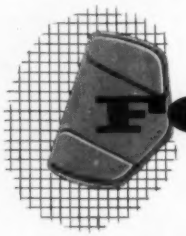
Typical of the higher performance users can now receive from Formsprag clutches is this specific example: A Formsprag clutch using Formchrome sprags was installed in the reaction member of a torque converter and a competitive clutch in another. The competitive clutch showed excessive wear after the equivalent of one year of operation. The Formsprag clutch was run 50% longer and still showed only negligible wear.

There is a Formsprag clutch for every application—from business machines to aircraft. Standard clutches cover a wide range of uses and are described in the Formsprag Catalog . . . send for your free copy. However, to meet unusual requirements, Formsprag engineers will modify a standard clutch or design a special—send your application details.

FORMSPRAG COMPANY
23587 Hoover Road, Dept. 102
Warren (Detroit), Michigan

In Canada: Renold Chains Canada, Limited
In United Kingdom: Renold Chains, Limited
Distributors in Principal Cities

*Formchrome sprags are produced under a patented process. The use of this process in the manufacture of over-running clutches is exclusive with Formsprag.



FORMSPRAG CLUTCHES

World's Largest Exclusive Manufacturer of Over-running Clutches

TYPICAL APPLICATIONS WHERE FORMCHROME SPRAGS HAVE PROVEN SUPERIOR PERFORMANCE

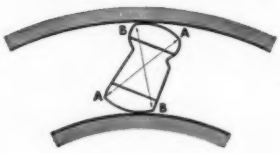
1. Used in operating submarine missile (Regulus II), Formsprag clutch allows alternator to over-run the hydraulic driving mechanism.

2. Backstop clutch on belt conveyor handling bauxite ore is subjected to higher over-running speed, extreme abrasive dust and hot weather—has been in operation a year.

3. Starter clutch for aircraft ground support system allows high-speed gas turbine to over-run starter unit.

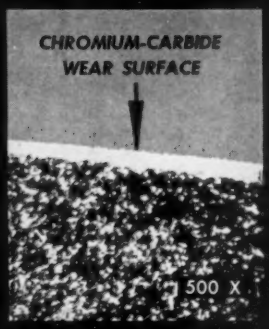
For additional information on how Formchrome sprags assure better performing clutches, write for technical paper "Formchrome Sprags".

HERE'S

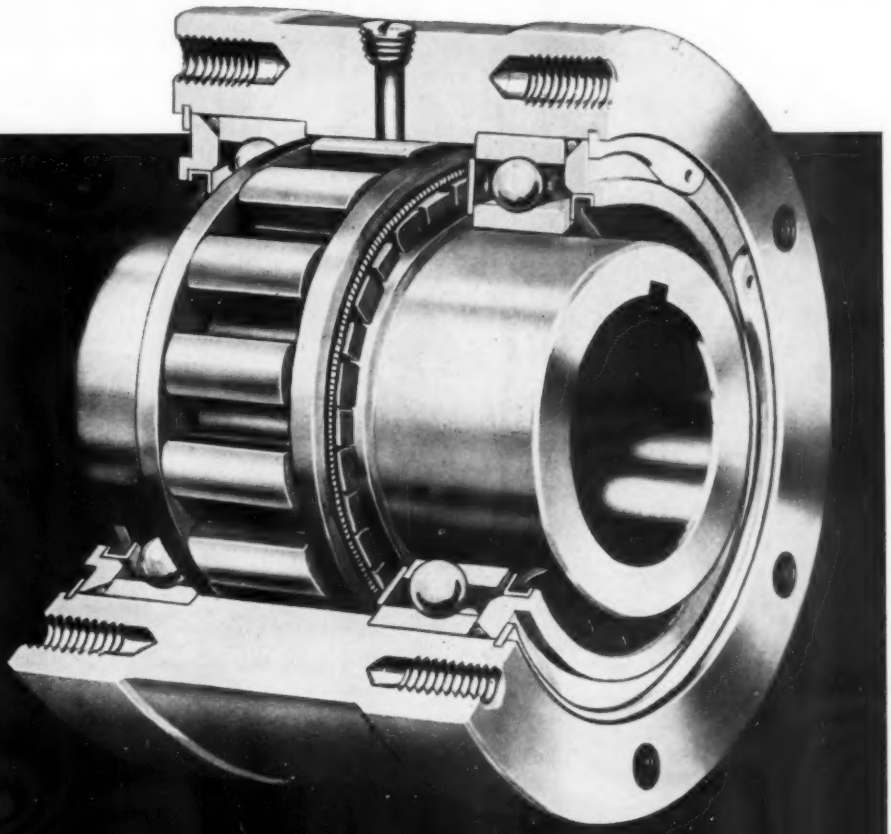


The Formsprag clutch consists of a full complement of shaped sprags, or wedges, located between concentric inner and outer races. Power is transmitted from one race to the other by the wedging action of the sprags. Each sprag is so shaped that dimension AA is greater than BB. Rotation of one race in the "driving" direction causes the sprags to wedge, transmitting torque in full from one race to the other.

FORMSPRAG OVER-RUNNING CLUTCHES WITH



Micro-photo showing chromium-carbide wear surface (1900 Vickers—80 R_c) of Formchrome sprags. Chromium is diffused into high-carbon alloy steel sprag (62R_c).



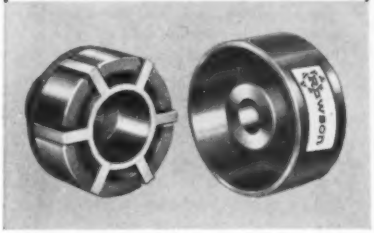
OVER-RUNNING · INDEXING BACKSTOPPING

HOW IT WORKS

An expanding coil spring keeps the sprags in light contact with both inner and outer races. There is thus no lost motion, the driving torque being instantaneously transmitted between races. The Formsprag Clutch is so designed that it will transmit a greater torque in relation to its size and weight, than any other comparable type of clutch . . . specify Formsprag on over-running, back-stopping and indexing applications.

Forcing a ball or roller into a curved, wedged space is an old over-running clutch principle. The sprag is, in effect, a "roller" of increased diameter with greater contact surface in a given annular space. Formsprag Clutches engage at constantly changing contact points. Clutch life is prolonged and backlash eliminated. Also, with the inclined surfaces discarded, more sprags can be inserted to increase torque capacity.

RAWSON FOR NO-LOAD STARTS



Specify Rawson Automatic Centrifugal Clutches and Clutch Couplings. They protect the prime mover, eliminate need for costly reduced voltage starting equipment, permit use of less expensive smaller motors to start high inertia loads. Completely automatic and entirely mechanical in operation. Rawson clutches provide full overload protection, never need adjustment. Write for the new Rawson Clutch Catalog now.

For more information circle No. 14 on the Reader Service Card

Servospeed
HEART OF AUTOMATION
MODERN ELECTRONIC ENGINEERING GIVES PRECISE MOTOR SPEED CONTROL
1/100 — 10 H. P.
Modern industrial electronic engineering has been coordinated with electric motor design to provide a versatile means for obtaining the full possible advantage of speed control in DC motors while operated from the regular alternating current power line. Grid controlled "Thyratron" tubes are utilized for power controlled stepless variation to supply motor armature power. Patented feedback, or "Servo" circuits provide constant torque capability over wide speed ranges of as high as 60 to 1 in some models and a minimum of 20 to 1 in others.
Servospeed
DIV. of ELECTRO DEVICES, Inc.
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ARmory 4-8989
Circle No. 26 on Reader Service Card

EDITOR'S PAGE

Let's try something new

David R. Cartwright
editor

HOW ABOUT JOINING THE WHATZZIT CONTEST?

We're starting a new thing called a Whatzzit Contest and invite you to participate. It only takes a few minutes and it may be rewarding to you. It's not a game; its for real, but you might as well have some fun while you're at it.

We've listed the rules below.

What is Whatzzit Contest?

Whatzzit contest is an opportunity for you, readers of POWER TRANSMISSION DESIGN, to pass along ideas you've had in the back of your minds for a long time that could help yourself or someone else work out power transmission problems.

Two Types of Entries

Your entries may be:

(1) An idea representing something you could build into actual hardware if you wanted to but have never had reason or need to do so.

(2) An idea of some mythical thing you could use, if it were available, and which you have never seen or heard of on the market.

For instance, a type 1 idea might be a simple design of a journal bearing made of organic fibers you work with in a textile mill, and you feel have tremendous frictionless properties if only someone would try them out as a bearing.

A type 2 idea might be a design of a 9-speed gear box that you could use in your work, if one existed, but which you've never seen or heard about.

Either way, someone may pick up the idea for his own use or let you know it is already in use on a product and could tell you where to get one. Full names and addresses will be used.

Whatzzit Contest Rules

Whatzzit contest letters should be addressed to:

Whatzzit. Contest
% The Editor
POWER TRANSMISSION DESIGN
812 Huron Road,
Cleveland 15, Ohio

Entries should include a penciled sketch of the idea on any kind of paper and a brief description in 100 words or less. No formality is required. An honorarium of $5.00 will be paid only for those actually published. Only a few can be used each month selected on the basis of idea originality and possible end usefulness. All entries become the property of Power Publishing Co., Cleveland, Ohio. Publication is not an endorsement of workability or guarantee of statements made. Contest is offered only as a means of stimulating ideas and rendering service to others who may be able to apply these ideas to end uses.

Dave Cartwright

Editor

Transmit Motion This Positive Low Cost Way!

TOUREK *"STANDARD"* BALL JOINTS

TYPE "A" BALL JOINT

Non adjustable spring type with a light pre-set tension. The shell is spun over the top cap bearing and a spring applies the tension of bearings against ball screw. This Ball Joint is used universally in hundreds of applications where excessive pressures would not be applied against the top cap.

TYPE "EC" BALL JOINT

Ball socket is located in same unit as cross drilled hole, giving added wall thickness. Ball stud with short neck allows more than 250 lbs. force against this unit. Swivel construction is assembled with a grease resistant neoprene washer to cushion movement and maintain proper tension. A spring clip allows rapid adjustment over great length. Stocked for rod sizes ¼" and 5/16".

TYPE "B" BALL JOINT

This is an adjustable spring type Ball Joint with cap bearing slotted one way. The threaded top bearing is assembled to maintain light tension against the bottom bearing and spring. A cotter pin is used to maintain proper adjustment. This type Ball Joint is ideal for applications requiring take up of wear.

TYPE "F" BALL JOINT

Low cost, trouble free unit readily adapted to various rod or shell sizes. Non adjustable type permitting 15° movement in any direction. No retaining devices needed. The type "F" should be applied where the higher cost of adjustable Ball Joints makes it necessary to substitute clevises, trunions, bent rods or other less effective ways to transmit motion.

TYPE "C" BALL JOINT

The type "C" Ball Joint is a positive adjustable type. It has no spring tension. The shell is cross drilled five ways. The fine pitch thread top bearing is inserted and locked by a cotter pin to provide desired free movement. Construction and adjustment features of this Ball Joint make it an outstanding number in the TOUREK line.

NEW SLIP-ON BALL JOINT

For quick assembly in "hard-to-get-at places". Slight retraction of outer shell exposes socket for quick insertion or withdrawal of ball. There are four component parts. 1. Shell 2. Outer housing 3. Spring 4. Ball Screw. This design completely houses compression spring and retains ball screw in its machined socket. Cotter pins, clips, or other retaining devices are eliminated.

Tourek
BALL JOINTS
The Recognized "STANDARD"

MAIL THE COUPON TODAY!

World's largest manufacturer of "STANDARD" Ball Joints. Also makers of Pipe Plugs and quality Screw Machine Products. Range: up to 2½" diameter single and multiple spindle machines. Operations include: Threading • Tapping • Milling • Drilling • Grinding • Polishing • Plating • Heat Treating • Silver Soldering.

ESTAB. 1920

J. J. TOUREK MANUFACTURING COMPANY
1901 SOUTH KILBOURN AVENUE, CHICAGO 23, ILLINOIS

Gentlemen:

Please mail to me at once, complete information and prices on TOUREK "STANDARD" Ball Joints, Rods and Linkages.

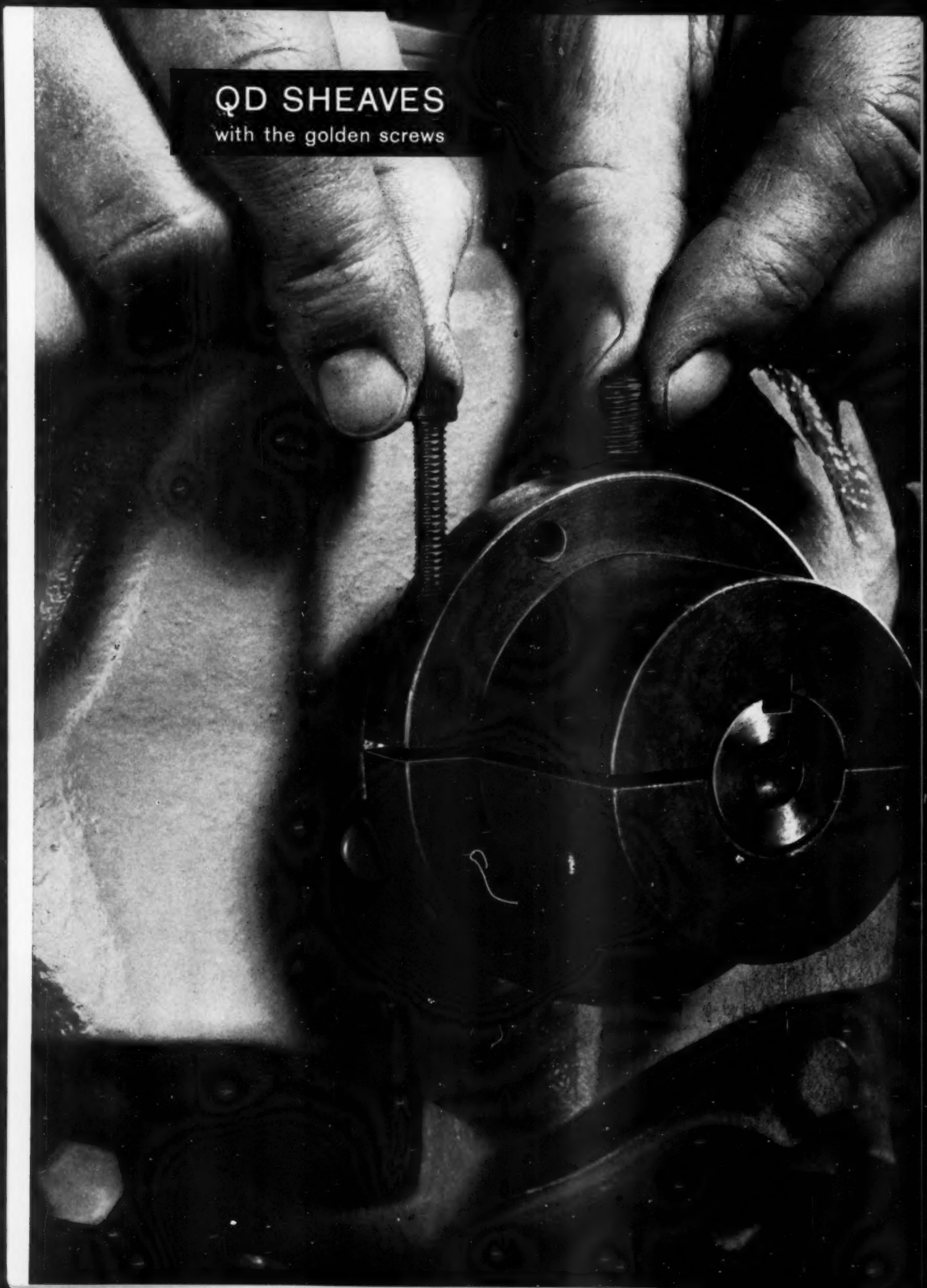
Name_____

Company_____

Address_____

City_____ Zone____ State____

For more information circle No. 29 on the Reader Service Card


QD SHEAVES
with the golden screws

Announcing
Worthington QD Sheaves
with the

GOLDEN SCREWS

Golden screws? That's right. All Worthington QD (Quick Detachable) sheaves now have two golden screws. Worthington has a reason for doing this: to demonstrate to you that the exclusive two-screw design is practically worth its weight in gold. These extra two screws are the big difference in sheaves.

The clamp screw simplifies installation and assures permanent alignment. You can install QD sheaves *one part at a time*. No heavy rim and hub combination to delicately inch into place. You just slide the hub on the shaft and permanently lock it in position with the clamp screw. Then you slide the sheave rim into position on the hub. This job is simplified because you engage the large end of the sheave with the small end of the hub. To change speed you simply install another sheave on the hub which remains anchored to the shaft by the clamp screw.

The set screw prevents "key drift." It locks the key securely in place, avoiding the danger of the key drifting off and becoming a safety hazard. This feature is appreciated by plant operators who first brought this potential danger to Worthington's attention.

You tighten the set screw without distorting the hub. The clamp screw allows you to locate the hub on the shaft. The locked hub then permits you to tighten set screw on key without distortion.

You can get Worthington QD sheaves anywhere in the U.S. More than 350 distributors carry Worthington sheaves and Worthington-Goodyear Green Seal V-belts. For your copy of a 100-page Multi-V-Drive Manual on how to select the right sheave and V-belt write to Worthington Corporation, Section 79-15, Oil City, Pa. In Canada: Worthington (Canada) Ltd., Brantford, Ont.

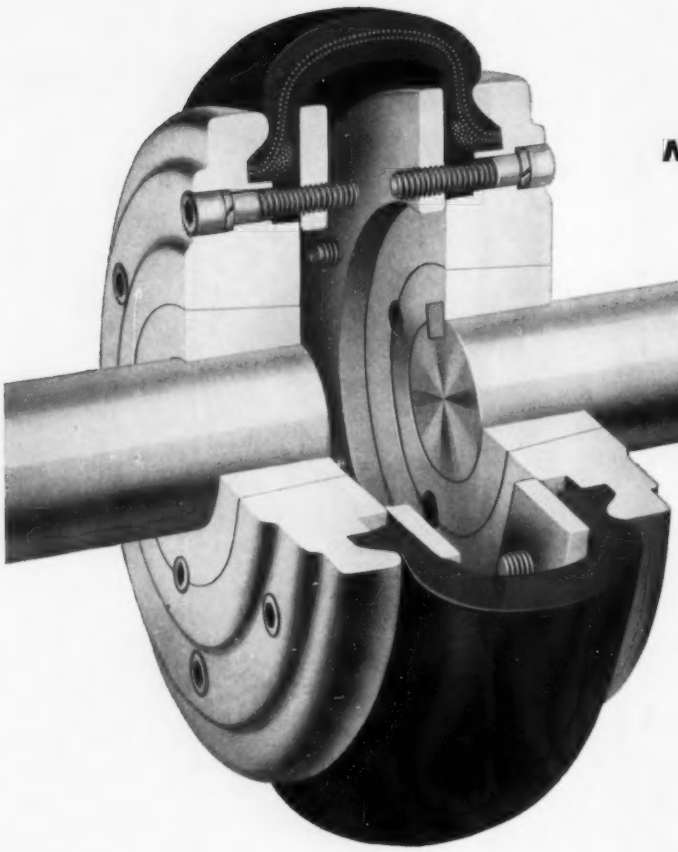
WORTHINGTON

Clamp screw locks hub to shaft for permanent alignment. Hub is locked in one piece—*no distortion* as set screw is drawn down.

Set screw locks key in place, prevents "key drift," a necessary safety feature.

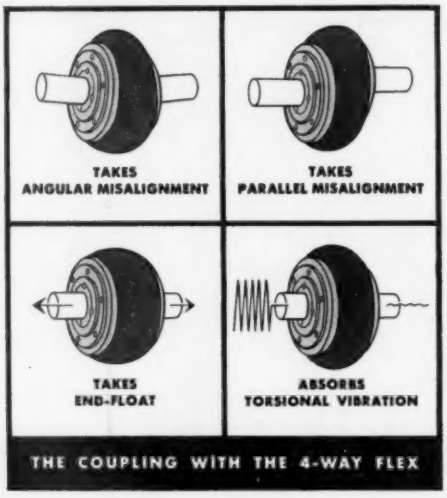
Pull-up bolts lock the sheave rim to the hub.

For more information circle No. 35 on the Reader Service Card



NEW!

DIFFERENT!



DODGE

Para-flex

FLEXIBLE CUSHION COUPLING

THIS coupling "swallows up" shaft misplacements. It automatically compensates for end-float, parallel misalignment, angular misalignment *or any combination of all three.* Moreover, it cushions the stresses of shock loads. And it absorbs torsional vibration—reducing noise and protecting machinery from vibration's destructive forces.

Here is a new type of performance—made possible by the development of a tire-like flexing element. Synthetic tension members, bonded together in rubber, give this element the stamina and dependability of modern, high-speed, high-load, shock-absorbing truck tires—and the ability to respond magically to all manner of changing shaft conditions.

Para-flex takes minimum space on the shaft. Mounting is simplified through the use of standard Taper-Lock bushings—no reboring, no machining. Safety is promoted by flush design; there are no protruding parts. No lubrication is required, no periodic inspection. And since the flexible member is molded with a transverse split, it can be replaced *without moving either the driver or driven machine.*

Para-flex Couplings are stocked by Dodge Distributors in popular transmission sizes. They are available from factory stock in capacities up to 825 hp at 1200 rpm. Call your distributor for early delivery to *make your own test.* You'll witness something revolutionary!

DODGE MANUFACTURING CORPORATION, 8200 Union, Mishawaka Ind.

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

For more information circle No. 11 on the Reader Service Card

Flexible shafts transmit power great distances

By JAMES DENNISTON and RICHARD HURLEY,
Columbus Div., North American Aviation, Inc.

FLEXIBLE SHAFTS actuate front wing flaps on a new supersonic aircraft. The shafts are powered by hydraulic motors which impart precise control and synchronous motion to all shafts. The shafts operate in unison and cannot produce uneven flap droop, either from lack of signal or pilot error. There are three shaft systems on each wing and they operate fixed amounts from fixed input signals.

The flaps produce a change in effective airfoil section when deflected. They increase lift and lower stalling speed to permit the aircraft to land at lower speeds on aircraft carriers.

Both the port and starboard leading edges are divided into four sections. Three sections are inboard of the wing fold; the other is outboard of the wing fold. Folding of the wings permits tighter parking patterns on carrier decks. The flexible shafts on these outboard sections have extendable links that let the shafts expand to greater working length without loss in strength or flexibility.

The flap elements are positioned by mechanical screwjacks. Hydraulic motors produce power for this through reduction gearboxes located within the wing.

During flight, flap deflection is controlled by the pilot from the cockpit. Droop amount is pre-determined according to aircraft speed as follows: for landing and take-off, 30 deg for the outboard flaps and 20 deg for the center and inboard flaps; for cruising, 8 deg for all; during supersonic flight, 0 deg for all.

The hydraulic system operates at 3000 psi through servo valves which control hydraulic motor speed and direction. The servo valves are manipulated by electric actuators through a mechanical system of cables, sectors and linkages. The spools in the servo valves return to neutral after final positioning through follow-up linkages. The linkages in both wings are tied together as a system and act to open and close ports in the valves to control the motors.

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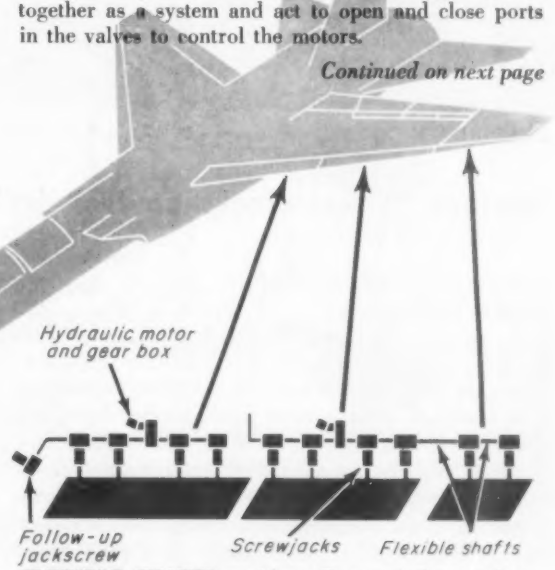
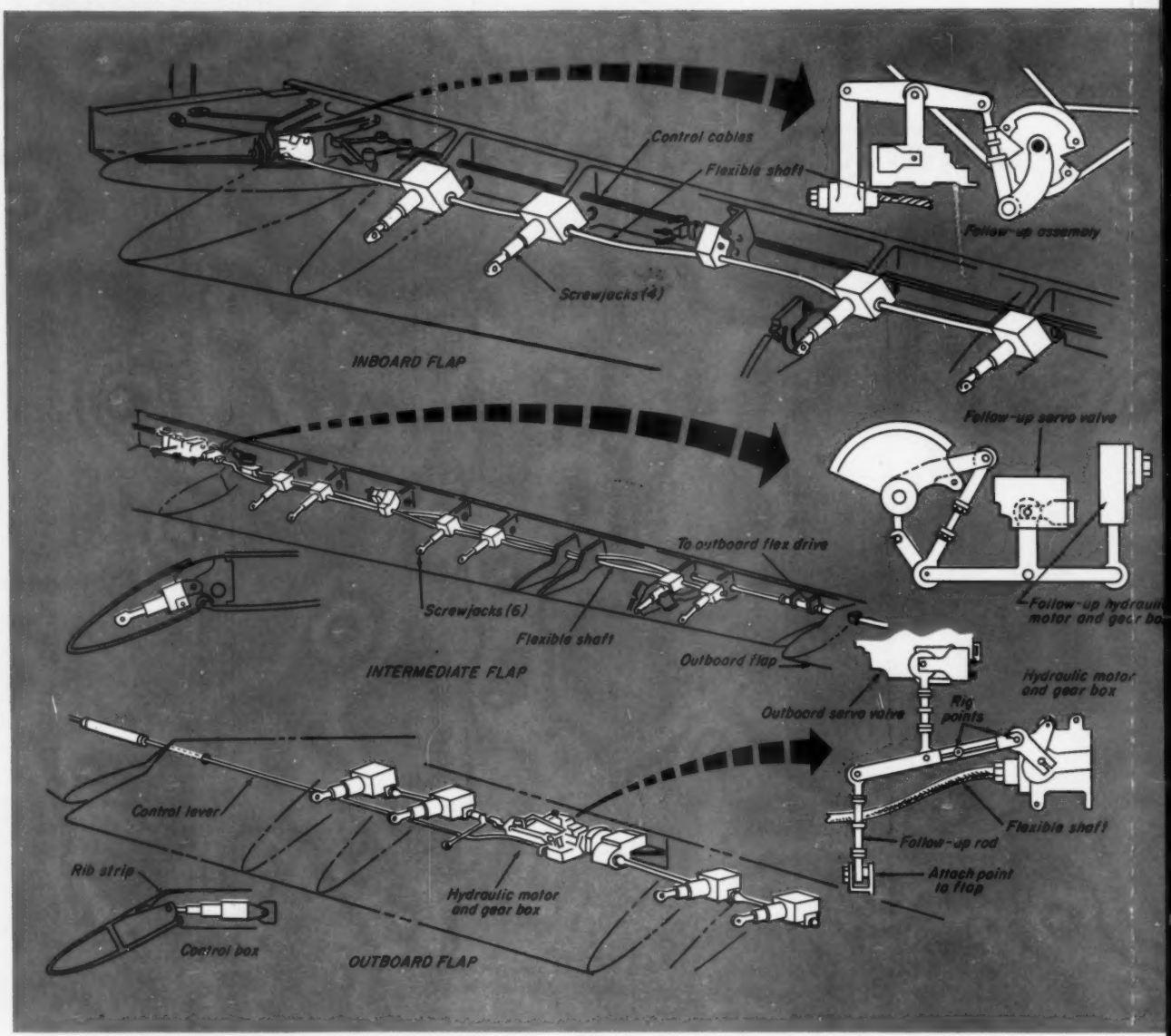


FLEXIBLE SHAFTS position all screwjacks evenly.



LEADING-EDGE FLAPS on supersonic A3J provide more lift for carrier landings.

Feature 1: screwjacks control deflection angle

SCREWJACKS are mounted all along the front inside of each wing to actuate the flaps. The screwjacks are powered by the flexible shafts series-fashion. As the shafts turn, all screwjacks in that series advance the same amount with mechanical synchronism. The screwjack pistons move against offset levers on the flaps causing rotation. Precise movement can thus be determined by the amount of piston extension.

Four screwjacks are used for each inboard and outboard flap; six screwjacks are used on each center flap. The screwjacks are mounted to the wing structure just aft of the flap panels.

The droop indicating system consists of a set of switches in each outboard wing panel with an accompanying indicator on the instrument panel. Two of the switches indicate droop angle; one switch in the starboard wing operates the off-position indicator. When the flaps are moving, this switch opens and the off signal becomes visible on the indicator.

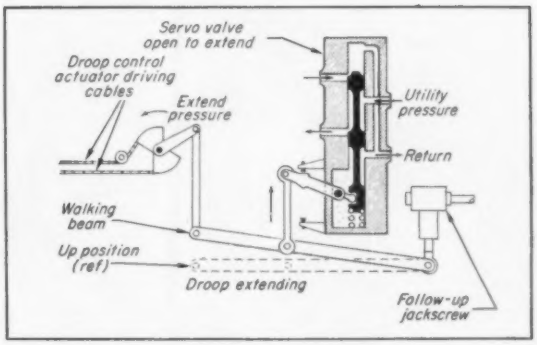
The screwjacks are linear actuators. The flexible shafts run through journal openings in the actuator housings and rotate the internal nut. As the nut turns, the screw advances the piston.

Feature 2: hydraulic motors control flexshaft rotation

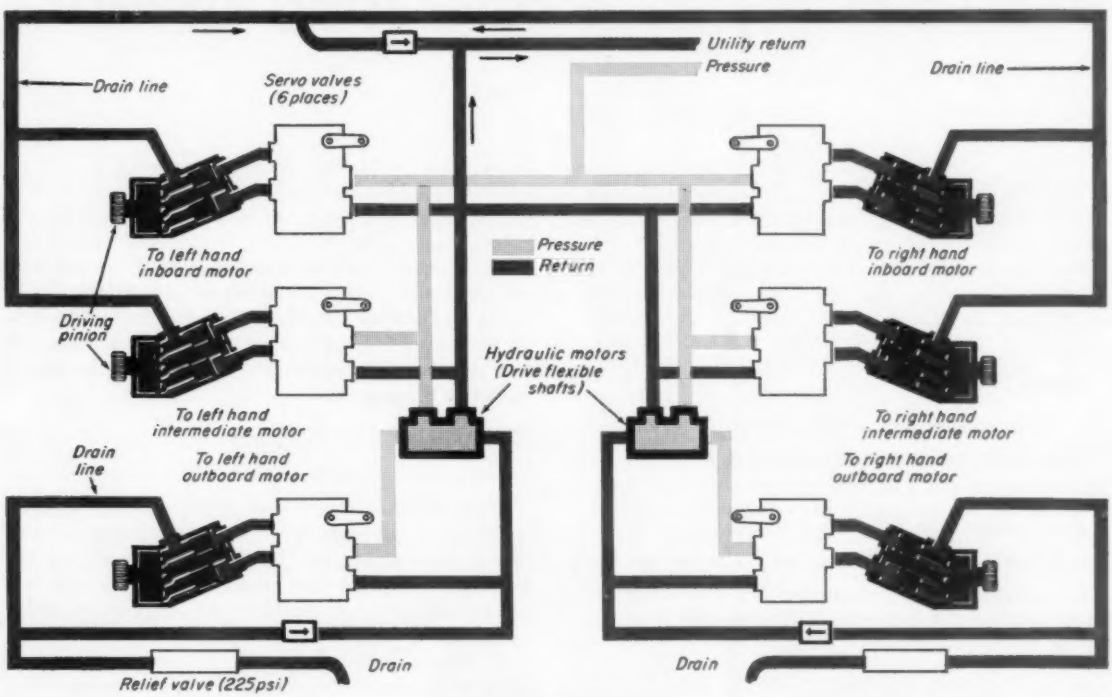
A FAIL-SAFE HYDRAULIC system positions the flaps. Oil pressure at 3000 psi is supplied to hydraulic servo valves that control the motors. The valve spools are mechanically actuated to control speed and direction of the motors. They are springloaded normally "up" which means that a break in either the control input or follow-up lines will cause the flaps outboard of the break to return "up" which is zero deflection; the remaining flap surfaces move as determined by the control handle. If hydraulic power fails, the surfaces stay fixed in the position at which the hydraulic fault occurred.

Actuation of the hydraulic valves is accomplished through a series of control cables and linkages. The system is inter-connected across both wings to cause simultaneous actuation of both starboard and port flaps. The control cables position the links connected to the valve levers. Movement of the cables thus causes port openings to change in the valves.

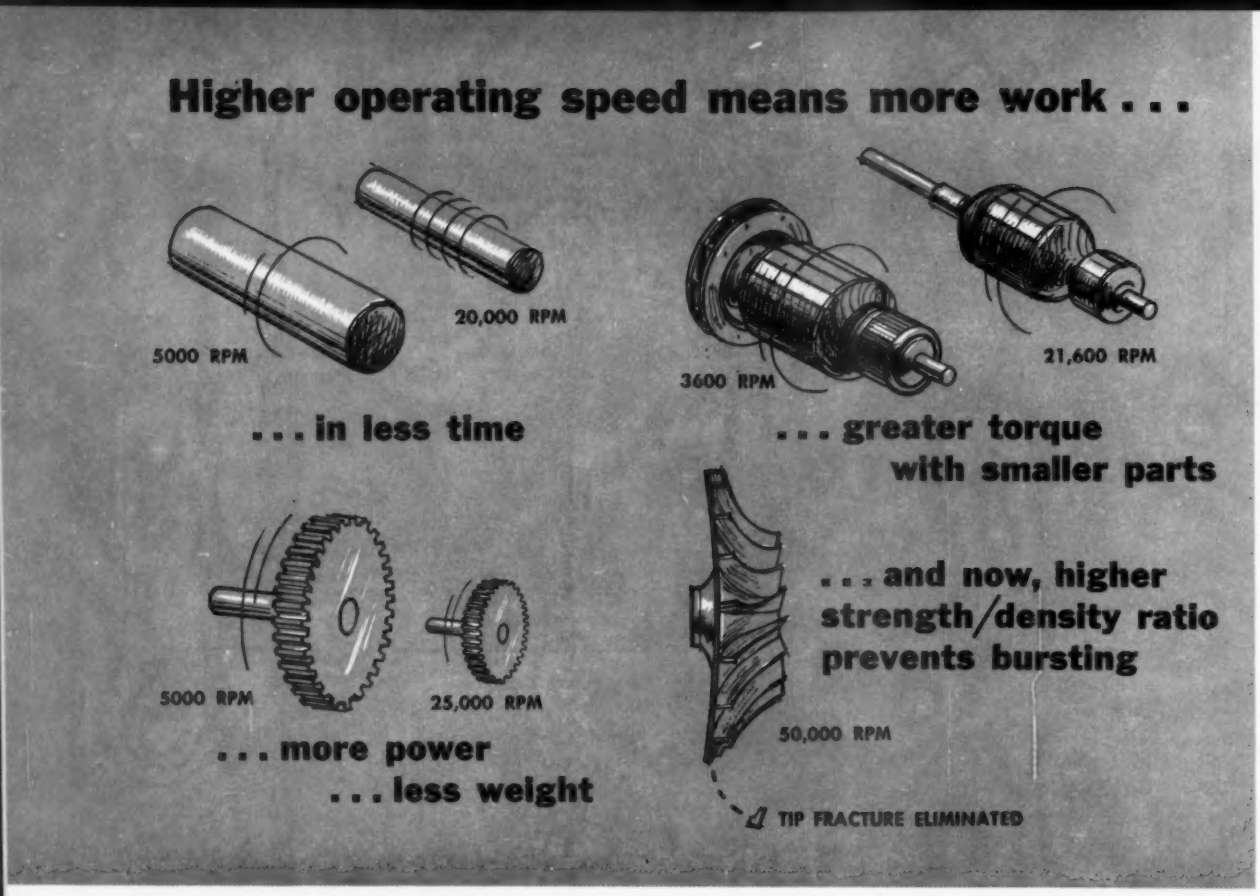
The valves vent hydraulic fluid to either side of the hydraulic motors which turn the flexible shafts in the required direction.



Each unit has a follow-up system that returns position signals to the valve linkage. These are actuated by follow-up screwjacks attached to the free end of the flexible shafts. The follow-up screwjacks, in turn, actuate servo valves linkages to produce hydraulic signals for balancing the input signals when the flaps reach desired position.



HYDRAULIC CIRCUIT sends same position signals to all six flexible shafts, prevents any from rotating improper amount.


Higher operating speed means more work . . .
5000 RPM
20,000 RPM
. . . in less time
3600 RPM
21,600 RPM
. . . greater torque with smaller parts
5000 RPM
25,000 RPM
. . . more power
. . . less weight
. . . and now, higher strength/density ratio prevents bursting
50,000 RPM
TIP FRACTURE ELIMINATED

Why not increase operating speed?

By L. F. HICKS, *associate professor, Ohio University*

ONE OF THE new areas into which the design engineer is being thrust is that of higher speed rotating equipment. Some of the items which must be considered are power, weight and size, cost, reliability or safety, and material. For different applications, any single item, or a combination, might be the decisive factor.

Power is defined as

$$P \sim \text{Work} \div \text{Time} \quad \ldots\ldots (1)$$

Work is defined as energy in transfer as

$$W = \text{Force} \times \text{Distance} \quad \ldots\ldots (2)$$

By combining the equations power is

$$P \sim \text{Force} \times \text{Distance} \div \text{Time} \quad \ldots\ldots (3)$$

Considering power transmitted by a rotating element, then force F traverses a circular path as shown in Fig. 1.

For one revolution, the distance traveled by F is $2\pi R$, and the work per revolution is

$$W = 2\pi F R \text{ or } 2\pi T \quad \ldots\ldots (4)$$

substituting this in equation (1)

$$P \sim 2\pi TN \quad \ldots\ldots (5)$$

Equation (5) can be made an equality by defining all terms and inserting a dimensional constant. Defining F in pounds of force, R in feet, T in foot-pounds, N in revolutions per minute, and P in horsepower, the dimensional constant is 33,000 and the power equation reduces to

$$P = \frac{2\pi FRN}{33000} \text{ or } \frac{2\pi TN}{33000} \quad \ldots\ldots (6)$$

This shows that torque and speed are directly proportional to given power. Or, by increasing rotative speed, more power can be transmitted with a given torque. This means that smaller shafts, motors, couplings and gears can do the equivalent work of larger components.

If torque supplied by the power source is not equal to the torque required by the system, acceleration occurs. Acceleration can be plus or minus and is included in the general equation

Is 60 cps power here to stay? Why not move up to 400 cps to enjoy the advantages of greater miniaturization? Power drives can then be smaller, more powerful, faster. End speeds need not change.

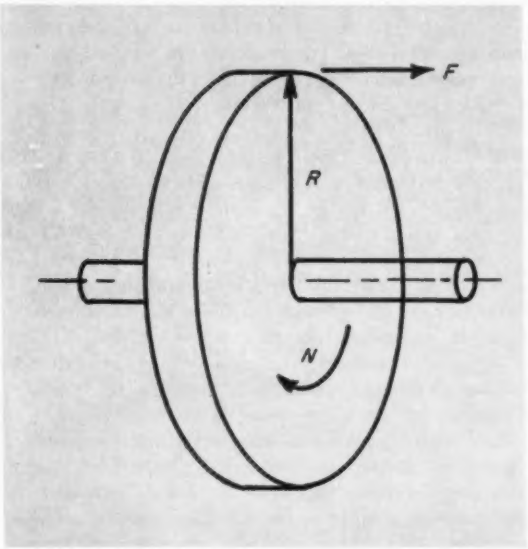


FIG. 1. FORCE F traverses a circular path

$$T = I\,\alpha \quad \text{.....(7)}$$

Term I is the rotational moment of inertia and α is the angular acceleration. If a system is subject to torque variations, as in the case of a reciprocating engine, the inclusion of a member with a large inertia will help stabilize speed. Some devices, such as record player turntables, are not subjected to such large torque fluctuations, but demand constant speed. In both cases, a large inertia will help by decreasing α for a given torque.

Rotational inertia is defined as

$$I = \int r^2 dm \quad \text{.....(8)}$$

Considering a simple cylindrical rotor as shown in Fig. 2, equation (8) can be reduced to

$$I = \int_{r_1}^{r_2} \int_{0}^{2\pi} r^2 \rho\, t\, r\, d\theta\, dr \quad \text{.....(9)}$$

which integrates to

$$I = \frac{\pi \rho t}{2} (r_2^4 - r_1^4) \quad \text{.....(10)}$$

However, the total mass of the rotor is

$$M = \pi \rho t\ (r_2^2 - r_1^2) \quad \text{.....(11)}$$

and by combining equations (10) and (11)

$$I = \frac{M}{2} (r_2^2 + r_1^2) \quad \text{.....(12)}$$

By increasing M or r, or both, the value of inertia may be increased. Not all applications require a large inertia. In some cases, it will be required that a rotor come up to speed with a small applied torque. To illustrate such an example we might choose a vacuum cleaner motor where the inrush current may be minimized by a low inertia rotor.

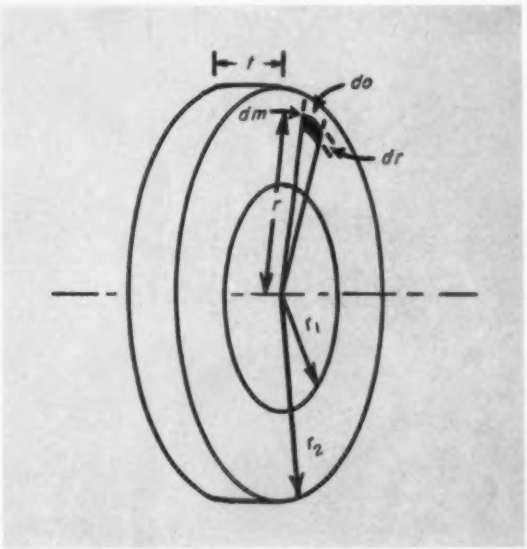


FIG. 2. ELEMENTS of a cylindrical rotor

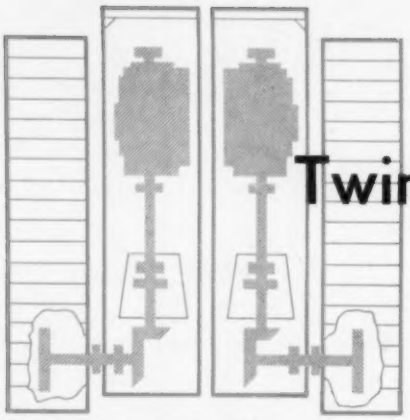
400 CPS Power

High-speed rotating machinery is not a cure-all. Considering electric motor drives, it is restricted by available frequency. Since commercial power lines are almost universally 60 cps, only speeds of near 3600 rpm or sub-multiples are obtained with conventional industrial motors.

Since military requirements place a premium on size and weight, 60-cycle power is not the most common. Many military devices are powered from 400 cps lines to increase speed and reduce weight and size. The use of 400 cycle power would boost industrial motor speed to 24,000 rpm or sub-multiples. This, like

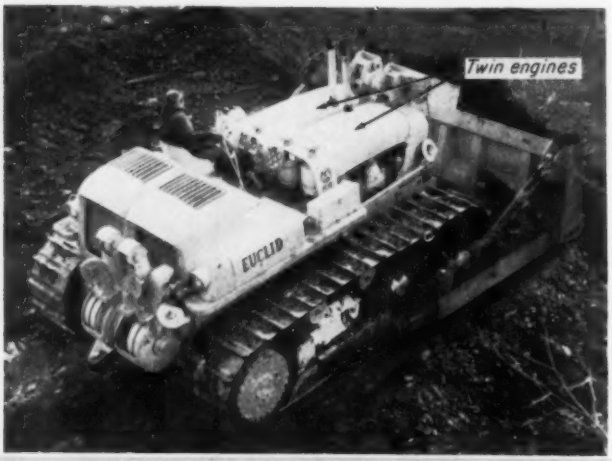
Continued on page 41

Twin drives effectively reduce



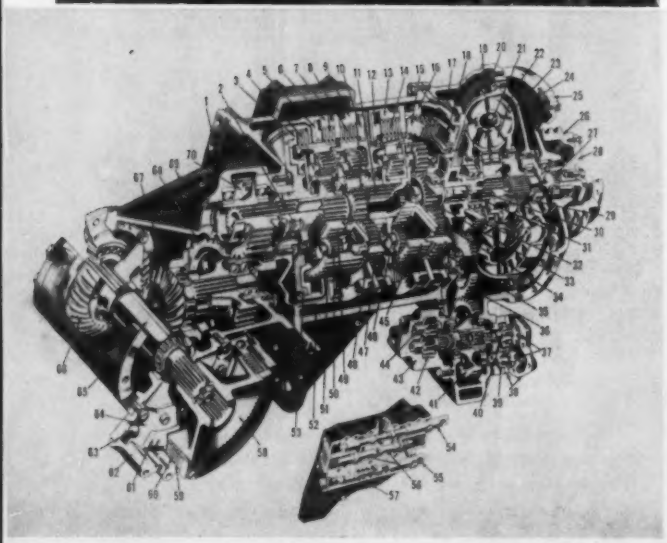
Two drive shafts

TWIN DRIVES greatly reduce size/hp ratio in a new crawler tractor. Instead of using one larger more powerful engine to produce required horsepower, two engines, mounted side by side, do more work—in a smaller size and weight tractor.



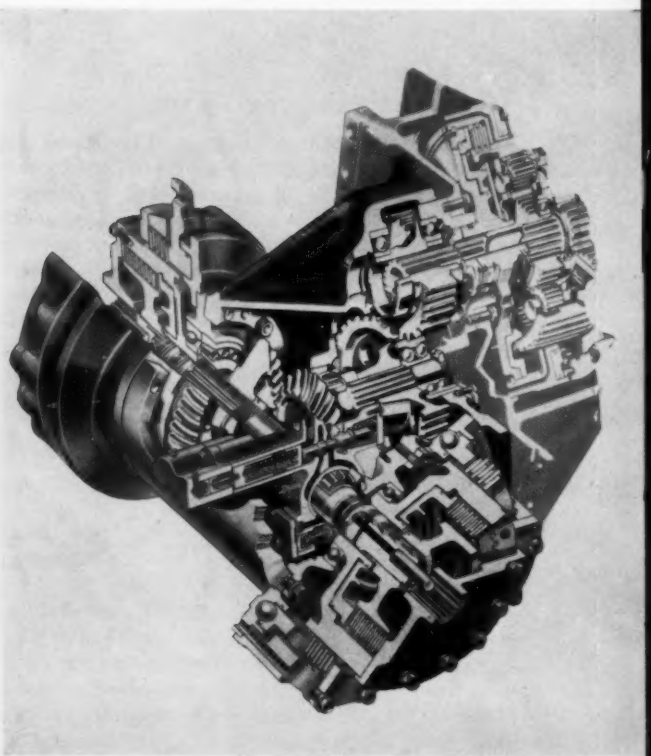
Net horsepower delivered to both tracks is 425 hp; 210 hp from each engine. This produces a total pull of 146,000 lbs at ½ mph. Each engine drives its own track permitting independent control of speed, power and direction. Varying the power to either track, either by throttle or shifting, produces better turning and greater flexibility during side slope work. In the same way, fast reversing and shifting in opposite directions gives more rapid turn-arounds and better maneuverability.

Each drive has a transmission, torque converter, right angle drive and final driving axle. The torque converter increases efficiency as speed increases. It also acts as a fluid coupling. The rotating stators withdraw at low torque to produce a straight trans-



Two transmissions

TWO DIESEL ENGINES operate on two-cycle principle. Each drives own track. Torque converters increase engine torque, and act as fluid coupling between engines and transmissions when increase in torque is not needed.



Two right angle reduction sets

size/hp ratio

BY RAYMOND WARNER, *supervisor, component application engineering, Euclid Div., General Motors Corp.,*

fer of power through the fluid. No clutches are used in either unit.

Transmissions

Each transmission consists of torque converter, planetary gear box and reduction gear box joined together as a unit. Each is mounted to a drive case and to the main frame by the planetary gear box rear flange. The converter housing is mounted to the front face of the gear box; the reduction gearing to the rear face inside the drive case. The drive case acts as the reservoir for the operating and lubricating oil.

Reduction Gears

The reduction gear assemblies have two functions: to change direction of power from the transmissions through 90 deg to the final drive shafts and to offer a gear reduction between the transmission shafts and final drives.

Each unit consists of a gear train which drives a pinion. The pinion is mated with a beveled ring gear which is splined to the reduction gearing output shaft. The output shaft is splined through a brake hub to a shaft which leads to the tractor final drive.

The brake assembly is mounted on the outboard side of the final drive. It consists of the brake hub an anchor bolted to the gear housing, a set of reaction plates and friction plates, a stationary cam ring, A movable cam ring and twelve steel balls. The brakes are actuated mechanically by moving the movable cam ring. This causes the balls to roll up ramps machined in the stationary cam ring, locking the brake hub to the anchor through the set of friction and reaction plates. This stops the output shaft from turning.

Planetary Gears

Planetary gearing is in constant mesh to give the operator a selection of speeds to meet various conditions. In addition, forward and reverse is controlled through this gearing.

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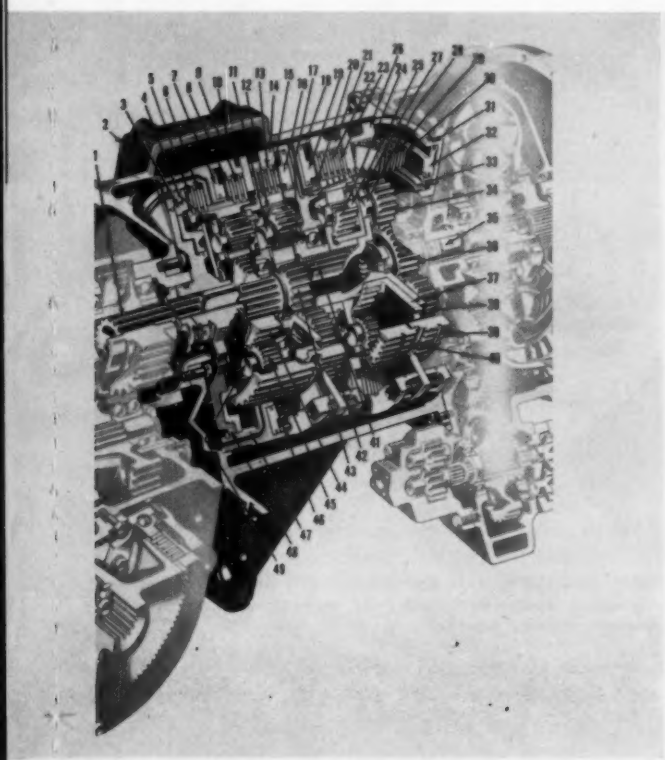
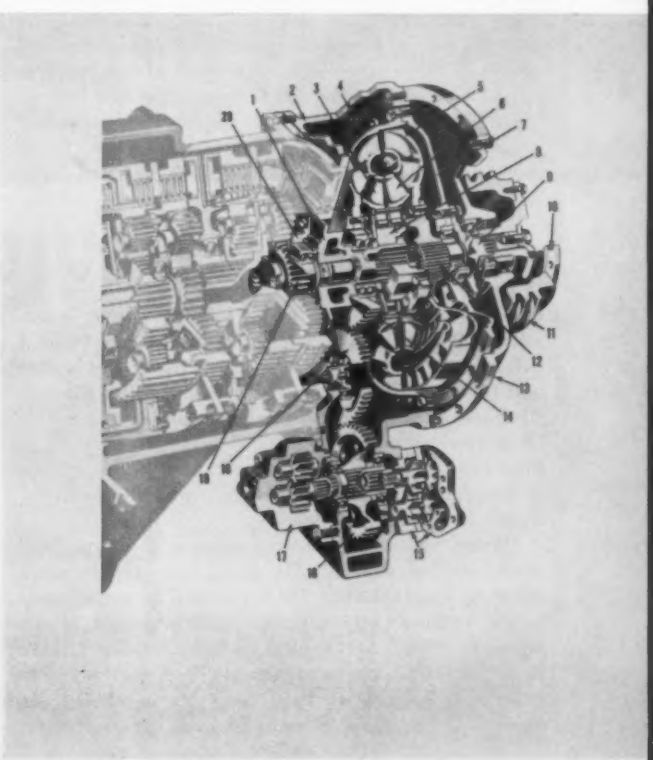
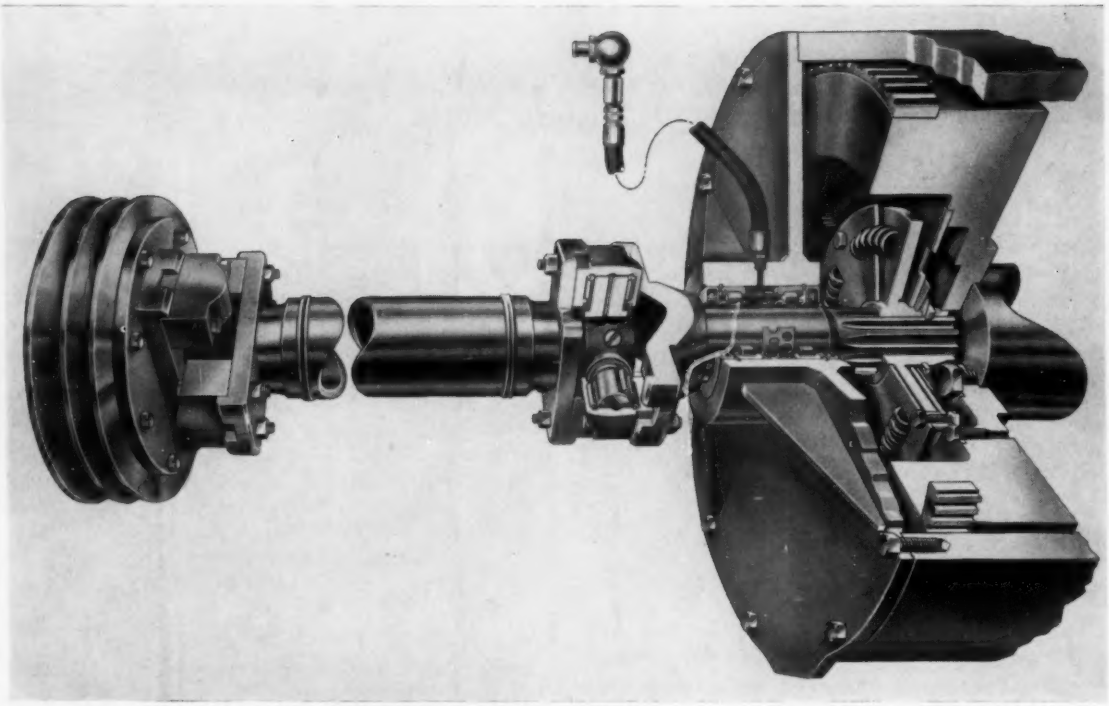


Two planetary gear sets



Two torque converters



EACH ENGINE has own drive shaft and flywheel. Shafts are hollow tubes, mounted in needle bearings.

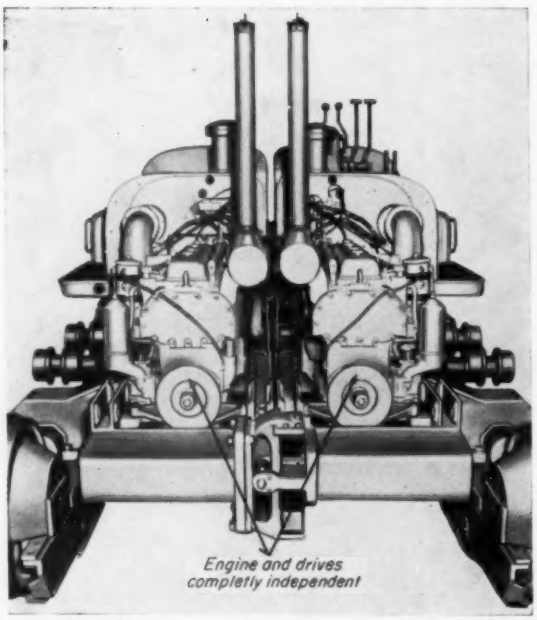
The gearing contains four simple planetary systems which are divided into two separate parts: forward and reverse, and speed or range. Forward and reverse utilize two planetaries, one to give forward direction to the final drive, and one to give reverse direction. The speed or range systems have two planetaries to give the operator a choice of three speed ranges. By using a combination of these two parts, the operator selects one of three forward speeds or one of three reverse speeds.

Torque Converters

The torque converters receive power from the engines and multiply it, within limits, before transmitting it to the planetary gears. Each converter is a two stage, stator type. It consists of a pump, two stators and turbine. The cover hub drives the pump through the cover. The two stators ride on rollers which ride on a race splined to a ground sleeve. The sleeve is bolted to the converter housing. The turbine is splined to the planetary gearing input shaft which rides in the inside bore of the sleeve.

During operation, the area between the pump and cover is filled with oil. The pump turns at the same speed as the crankshaft. Oil is directed from the pump to the turbine. At the turbine, oil is caught in the vanes to impart mechanical rotation to the turbine in the same direction as the pump.

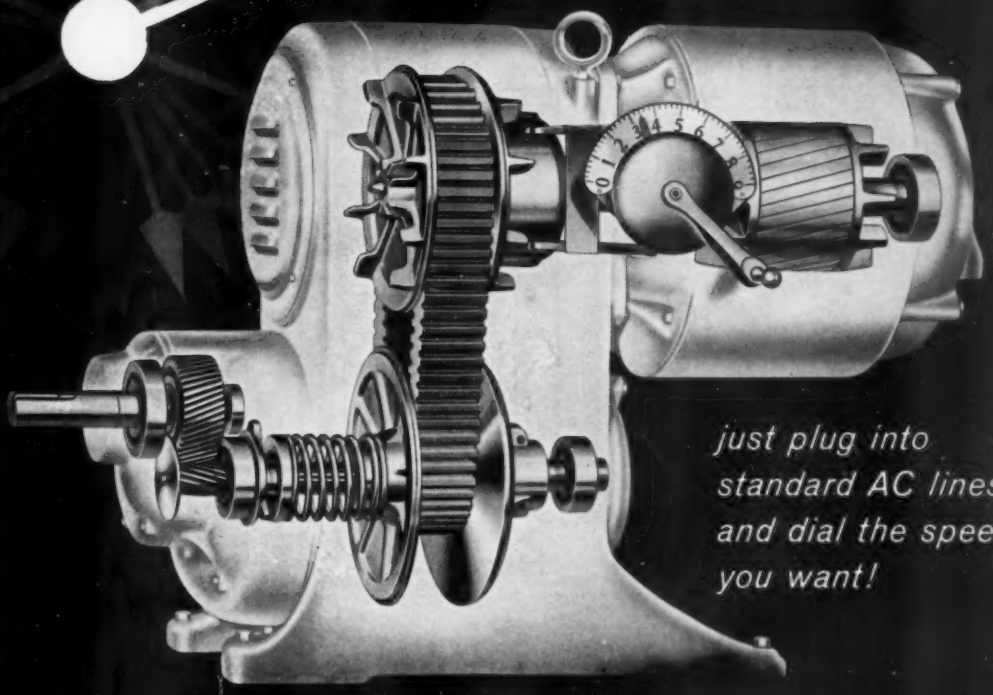
To gain maximum force from the oil being delivered by the pump, the turbine changes oil direction to the maximum degree. The oil flows from the outer circumference of the turbine to its center and



TWO ENGINES, two transmissions—twin everything —produce more work per size or weight than any previous crawler tractor.

Continued on page 55

any RPM simply on AC!



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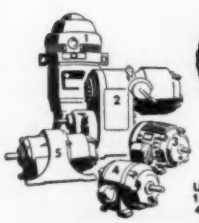

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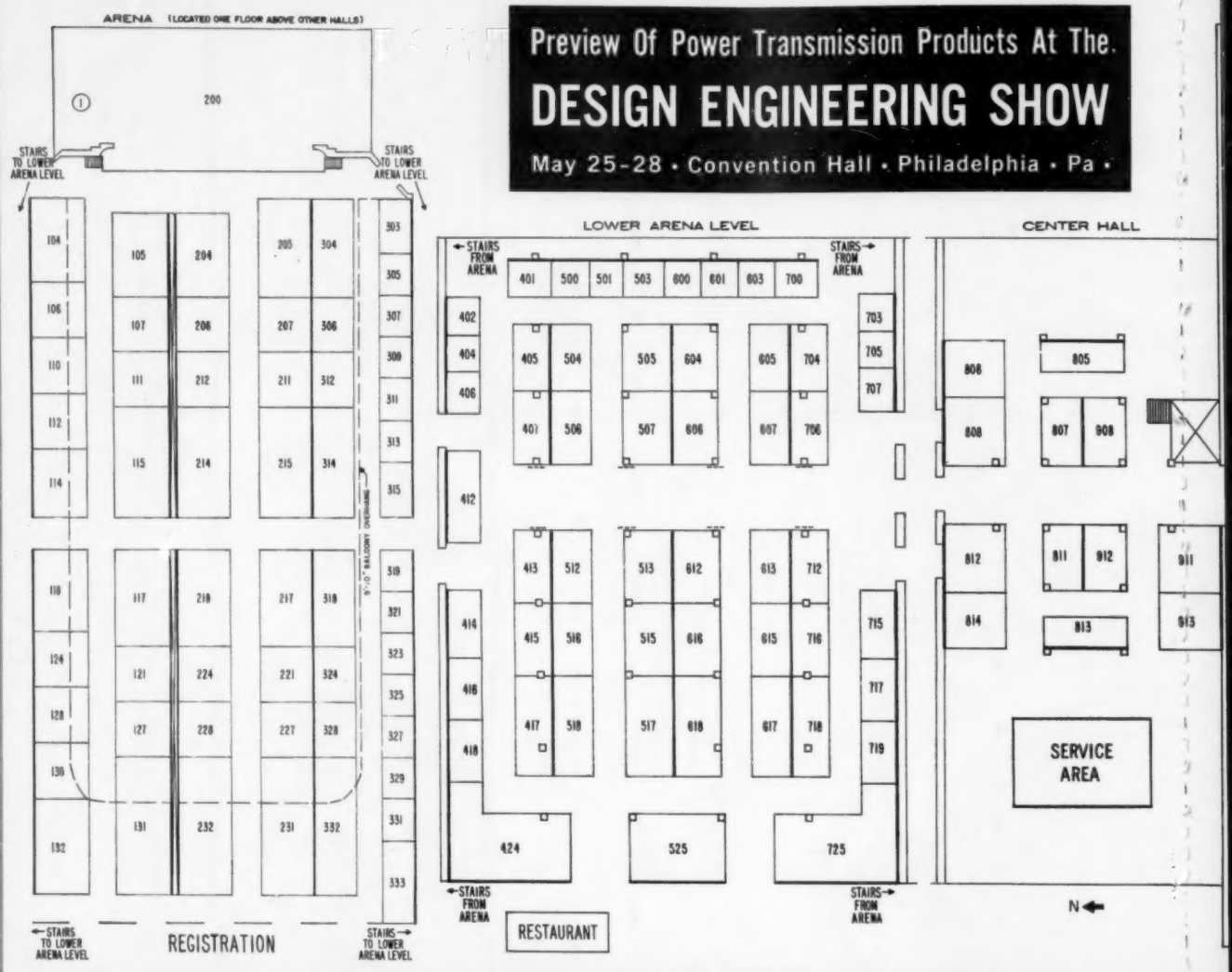
For more information circle No. 30 on the Reader Service Card

Preview Of Power Transmission Products At The DESIGN ENGINEERING SHOW

May 25-28 • Convention Hall • Philadelphia • Pa •



Following is a partial list of products to be featured by companies responding to our questionnaire.

Booths 206, 212, 214—*Haynes Stellite Co., Div. of Union Carbide Corp., Kokomo, Ind.*

High-performance parts

Variety of bearings, bushings and sleeves made from Haynes alloys. Heat-, corrosion-, and abrasion-resistant for applications where operating conditions are unusual. Ideal for conditions where lubrication is impossible or maintenance infrequent.

Circle number 200 on reader service card

Booth 215—*General Electric Co., Schnectady, N. Y.*

DC servo-motors

High-power, variable-speed. Provide fast response to control signals where frequent stops and starts, reversals and widely fluctuating loads are involved. Will operate at any angle with any dc control power supply.

Circle number 201 on reader service card

Fractional HP motors

DC motors, tachometer generators, amplidynes, etc. for closer control of speed, position and torque. Variable-speed characteristics permit more versatile, fuller use of complicated control mechanisms. 1/20 to 1 hp motors in several enclosure styles for standard speed rates and voltages.

Circle number 202 on reader service card

Booth 221—*Roller Bearing Co. of America, West Trenton, N. J.*

Roller bearings

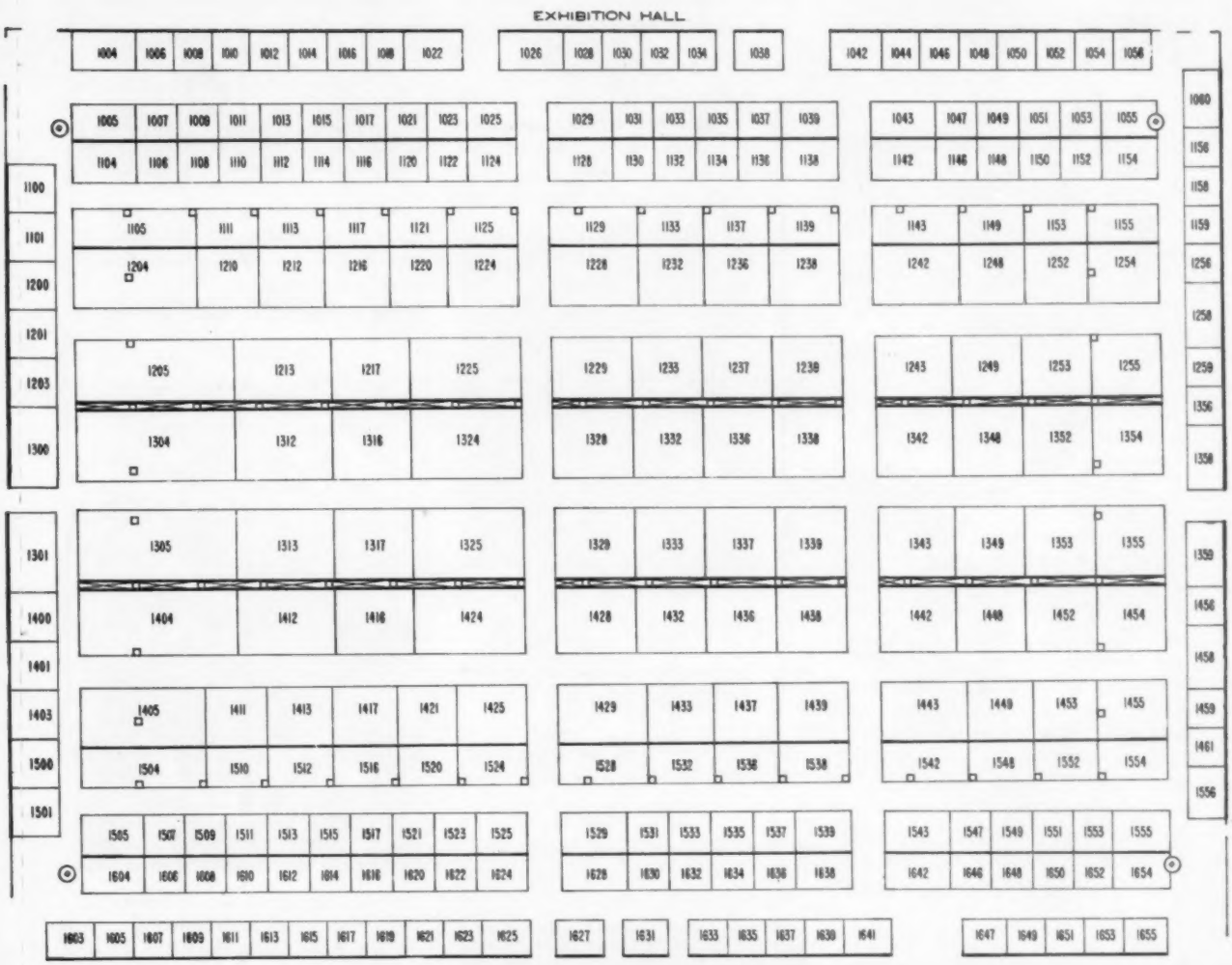
Pitchlign roller bearings prolong life of bearings with more uniform load distribution, individually aligned rollers and a minimum of effort by the cage.

Circle number 203 on reader service card

Booth 304—*The Louis Allis Co., Milwaukee, Wis.*

AC adjustable drive

Adjusto-Spede drive provides any required speed within its range by turning of speed-setting knob. Operator's station, mountable anywhere, includes all controls. No motor-generator set



required. Same shaft height and diameter as comparable hp ac squirrel-cage motors for ease of adaption. ¾ to 7-½ hp, 100 to 3400 rpm for continuous operation at constant torque, 0 to full speed.

Circle number 204 on reader service card

Booth 313—*Cullman Wheel Co., Chicago, Ill.*

Weld-on hub

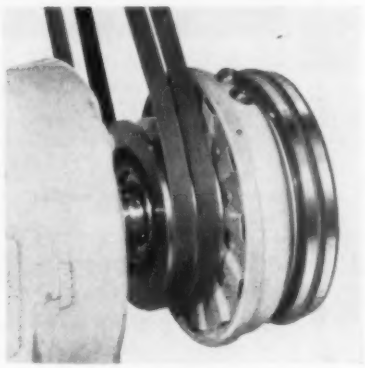
All-steel Weld-On-Hub guards against improper assembly of sprockets, pulleys, gears, couplings, etc. Set screws mount flush with hub surface, with installation or removal by means of head key. Accompanying steel split tapered bushings give full grip on undersize shafts.

Circle number 205 on reader service card

Booth 314—*Warner Electric Brake & Clutch Co., Beloit, Wis.*

Clutch-pulley drive

Electro-Sheave is a combined electric clutch and sheave assembly for direct installation on all standard electric motor shafts. It permits electric no-load starting without complicated adapting of standard electric clutches to the primary shaft. Clutch engages or releases instantaneously at any speed and permits precise inching or jogging starts in fraction of one revolution, thus minimizing wear. When clutch is disengaged, sheave runs freely on anti-friction bearings with no transmission of torque to the shaft.

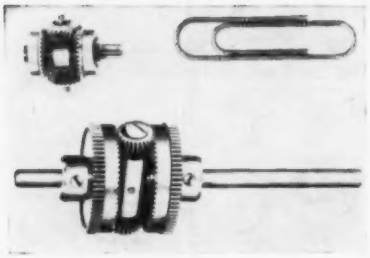


Circle number 206 on reader service card

Booth 404—*Dynamic Gear Co., Inc., Amityville, N. Y.*

Face gear differentials

Ultra-miniature line of hollow-shaft and face gear differentials for Pre-



cision Class I or II specifications. Hollow-shaft differentials for 1/16 and 1/8 in. shaft diameters; face gear shaft diameters 1/8 and 3/16 in.

Circle number 207 on reader service card

Booth 332—*La Salle Steel Co., Chicago, Ill.*

Steel bar shafting

Stressproof steel with copper gives 100,000 psi minimum yield strength in all sizes. Specially suitable for most shafting applications because strength and stamina are achieved without heat treating. 50 to 100% faster machining than carbon or alloy steels of the same hardness. Fatigue-proof bars made from company's Elevated Temperature Drawing process have same qualities with added tensile strength of 140,000 psi and minimum hardness of Rc 30. Round, ¼ to 3-⅜ in., hexagonal, ⅜ to 2 in.

Circle number 208 on reader service card

Booth 407—*Web Controls Corp., Paterson, N. J.*

Automatic tension control

For any machine that winds or unwinds. Specially suited for remote actuation, servo-control, speed and process control, etc. Continuous oil film is subject to shear and provides torques varying with voltage fed into magnet. Seven styles give torque selections from .9 to 520 lb-ft.

Circle number 209 on reader service card

Booth 516—*Mobay Chemical Co., Pittsburgh, Pa.*

Urethane parts

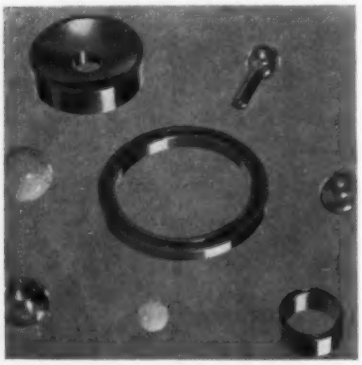
Urethane rubber synthetic elastomer is tough, friction-resistant and easily machinable. Wide applications in bearings, chain and belt drives, shafting and couplings.

Circle number 210 on reader service card

Booth 504—*Industrial Tectonics, Inc., Ann Arbor, Mich.*

Radial bearings

Seven stock sizes of deep-groove antifriction radial bearings for operation to 900° F. Company also has full line of metal and non-metallic precision balls, from .005 to 4 in. diameter, and



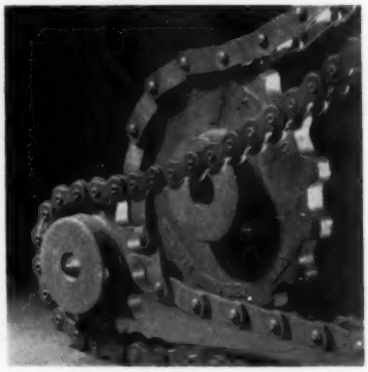
custom-engineered bearings for high temperature and corrosion resistant use.

Circle number 211 on reader service card

Booth 605—*Chain Belt Co., Milwaukee,, Wis.*

Roller chains

Rex ASA precision chain for high-fatigue strength in high-speed and heavy-load use. Single or multiple

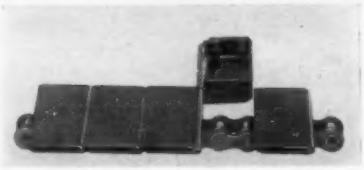


strands with precision-fitted sprockets. Chabelco steel chains built to close tolerances and heat-treated for heavy-duty drives at slow to moderate speeds.

Circle number 212 on reader service card

Nylon plate chain

Rex nylon-plate top-roller chain uses Rex ASA chain components with nylon top plates snapped onto extended



pins. For flat-top conveying applications where smooth conveying essential. Combines Rex chain strength with nylon properties.

Circle number 213 on reader service card

Booth 600—*G. H. Leland, Inc., Dayton, Ohio.*

Stepping motors

Syncramental stepping motors translate pulses into incremental shaft positions. 36 deg angular increment per pulse gives 10 indexing positions at

stepping rate to 15 per second within wide range of environmental conditions. Load capacities from 13 oz. in. to 2 lb-in. Uni- and bi-directional.

Circle number 214 on reader service card

Booth 603—*Coors Porcelain Co., Golden, Colo.*

Ceramic rotary seals

Mechanical seals for shafts from ¼ to 6 in. shafts. Variously shouldered and notched. Ceramic seal surface generally used in conjunction with graphite, metal or plastic surface.

Circle number 215 on reader service card

Booth 717—*Alemite Div., Stewart-Warner Corp., Chicago, Ill.*

Lubrication systems

Accumatic centralized lubrication systems deliver exact amount of lubricant at required intervals from one central point, via pipe or tube and

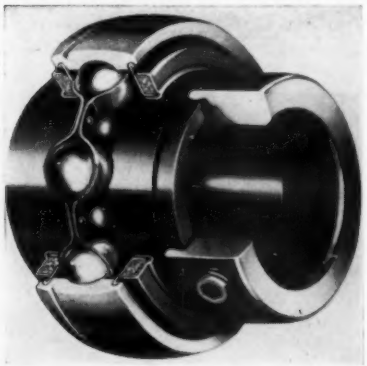
individual feeder valves, to each bearing. Avoids physical difficulty, danger or inexact amounts. Handle any fluid oil or soft grease at maximum valve temperature of 200 F. Systems service up to 400 valves.

Circle number 216 on reader service card

Booth 704—*Hoover Ball and Bearing Co., Ann Arbor, Mich.*

Collar-lock bearings

Eccentric collar-lock machine unit ball bearings come with spherical seat for automatic self-alignment or with



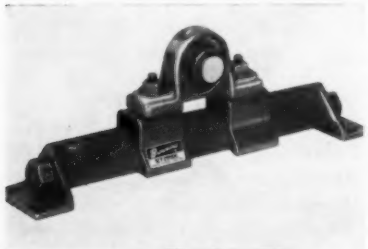
straight outer diameters for more rigid shaft location. 32 shaft sizes from ¾ to 2-15/16 in.

Circle number 217 on reader service card

Booth 911—*Browning Mfg. Co., Maysville, Ky.*

Bearing units

Pillow and flange blocks made of Malleable for stronger, more compact design. 29 standard shaft sizes from ½ to 2-7/16 in. Low or high heights



in each size, with elongated slots to allow interchanging as replacement parts with other styles. Also complete units with self-aligning ball bearings, lubricated for life and sealed.

Circle number 218 on reader service card

Continued on next page

NEED
GEARS?
Eliminate "high-cost specials"
by standardizing on
AMERICAN STOCK GEARS
Investigate and you'll probably find that instead of having to go to the added time and expense of ordering special gears, that your needs can be filled from the American line.
American is a 'complete' stock gear line. Manufactured by Perfection — a veteran of over 30 years in the gear business — these gears are made to the most precise standards, from the highest quality materials. This popular line includes brass, bronze, steel, semi-steel, cast iron, and non-metallic gears in a range of 48 to 3 diametral pitch.
You'll save time and money . . . save on inventory . . . simplify purchasing and have less lost production time by procuring your stock gear needs from your nearby distributor of American Stock Gears.
Ask for FREE copy of American Stock Gear Catalog No. 360 containing detailed information and engineering data.
AMERICAN STOCK GEAR division
Perfection Gear Co., Harvey, Illinois

For more information circle No. 23 on the Reader Service Card

Continued from preceding page

Booth 1007—*Hartford Steel Ball Co., West Hartford, Conn.*

Bearing line

Vers-o-line bearings specially developed for individual applications. Often use functional parts of end products to form bearing races. Unitized construction. Single row, opposed angular contact and thrust series. High precision with controlled tolerances.

Circle number 219 on reader service card

Booth 1008—*Farley & Loetscher Mfg. Co., Dubuque, Iowa.*

Plastic parts

Gears, pinions, cams and bearings machined from Farlite high pressure plastic laminates are smooth running, noiseless and light weight. Sheets or blanks can be machined to exact dimensions with little warp tolerance.

Circle number 220 on reader service card

Booth 1015—*Arguto Oilless Bearing Co., Philadelphia, Pa.*

Oilless bearings

Arguto-MP. Made from plastics alloy. Excellent wearing qualities. No need for re-lubrication.

Circle number 221 on reader service card

Bearing testing machine

Arguto Universal bearing testing machine allows accurate testing of two types of bearings simultaneously. Test results include bearing wear, shaft wear, weight loss and final PV values for wide range of speeds, loads and times. Used for testing oilless and dry lubrication bearings, journal bearings with various types of drop feed lubrication, rolling element and sliding bearings.

Circle number 222 on reader service card

Booth 1025—*Simplatrol Products Corp., Worcester, Mass.*

Fixed-field clutches

Super-compact for stationary installations where space is limited and performance requirements high. Eliminate torque-carrying splines. Simplatrol diaphragm only moving part. Three styles: coupling, clutch and coupling-brake. 6 sizes from 7/8 to 3-1/8 in. diameter. Torque output from 10 oz-in. to 100 lb-in.

Circle number 223 on reader service card

Electric clutches and brakes

Full line: miniature, small and large. No gears, cams, levers. Fast reaction time with electrical control for gradual or sudden stop and start. No sliding parts; 13 sizes; torque output from 10 oz-in. to 470 lb-ft.

Circle number 224 on reader service card

Booth 1021—*The Bunting Brass and Bronze Co., Toledo, Ohio.*

Bearing aluminum bars

New product with company. Bearing aluminum bars of higher quality than comparably priced bronze bars. Tubular and solid, outside diameters from 1/2 to 7 in. Need no special care in fitting.

Circle number 225 on reader service card

Booth 1348—*Barry Controls Inc., Watertown, Mass.*

Vibration isolators

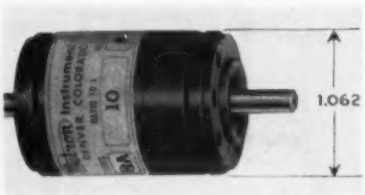
Several series of Barrymounts isolate vibration and noise caused or transmitted by motors or motor-driven equipment. Within load limits (30 to 260 lb per isolator) isolation efficiency reaches 60 to 85% at 20 cps.

Circle number 226 on reader service card

Booth 1031—*Metron Instrument Co., Denver, Colo.*

Miniature speed changers

Series 8 ideal for use in cameras, oscillographs, chart drives, servomechanisms. Input and output shafts run in double ball bearings, countershafts in special sintered iron and copper self-lubricating bearings. Spur gears 96 pitch, 20 deg pressure angle. Ratios from 1:1 to 5:1 for torque up to 16 oz-in, 6:1 to 531441:1



for torque to 24 oz-in. measured at low-speed shaft. Speeds to 10,000 rpm at high-speed shaft. Maximum power output at low-speed shaft .025 hp.

Circle number 227 on reader service card

Booth 1117—*T. B. Wood's Sons Co., Chambersburg, Pa.*

Flexible couplings

Sure-Flex couplings withstand all types and combinations of misalignment without wear or high resisting forces. Exceptional torsional flexibility (to 15 deg at peak torque), absorption of vibration and shock.

Avoid overhung loads affecting shafts. Flexing occurs within rubber sleeve, generating no pulsation or imbalance. Styles for various combinations of angular misalignment to 1 deg, parallel misalignment to 1/16 in., end float to 1/8 in. No lubrication needed.

Circle number 228 on reader service card

Booth 1105—*Dodge Mfg. Corp., Mishawaka, Ind.*

Dry fluid drive

"Fluid" in Flexidyne drive is heat-treated steel shot. Measured amount, the flow charge, is contained in housing which is keyed to motor shaft. Centrifugal force of rotating motor throws flow charge to perimeter of housing, between housing and power-transmitting rotor. Housing and rotor become locked together without slip and with full efficiency. 8 stock drives, 10 stock couplings, fractional to 1000 hp.

Circle number 229 on reader service card

Booth 1121—*Franklin Electric Co., Inc., Bluffton, Ind.*

Instant-reverse motors

Instant-O-Verse device means instant reversal at any time during cycle. Automatically pre-set by shaft rotation. No reduction of speed or wait-

ing, full torque is maintained. Does not interrupt circuit, no contact arcing possible. Company supplies motors 1/6 to 1 hp for numerous domestic and light industrial uses.

Circle number 230 on reader service card

Booth 1138—*The Hilliard Corp., Elmira, N. Y.*

Single-revolution clutch

Ensures automatic, positive, non-slipping intermittent motion in machines with continuously rotating source of power. Various mounting positions for specific motion control. Inner driven hub carries tripping mechanism, disengages driving power at same point of rotation for each cycle. Stopping point maintained within plus or minus 3 deg from cycle to cycle. Standard sizes for either clockwise or counter-clockwise operation. Special finishes and styles for fractional revolution operation available.

Circle number 231 on reader service card

Over-running clutch

Allows driven member of machine to over-run or free wheel either because driver is stopped or because another power source increases driven speed. Individual roller springs keep rollers always ready for action, with no backlash or lost motion. One model, Wedge-Roll, has 4 sizes with hp from 1.8 to 36 at 100 rpm, torque from 100 to 1900 ft-lb. Other types and sizes available.

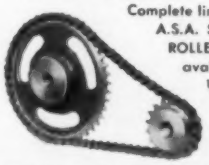
Circle number 232 on reader service card

Continued on next page

Do YOU Have a Power Transmission PROBLEM?

No. 25 Actual Size Pitch 1/4" Width 1/8"
No. 35 Actual Size Pitch 3/8" Width 3/16"
No. 41 Actual Size Pitch 1/2" Width 1/4"
No. 40 Actual Size Pitch 1/2" Width 5/16"
No. 50 Actual Size Pitch 5/8" Width 3/8"

Complete line of A.S.A. STANDARD ROLLER CHAINS available from ¼" to 2½" Pitch



Complete line of stock bore, steel and cast iron single sprockets, cast iron hub sprockets and all steel split or solid hub sprockets available, also large selection of finished bore sprockets.

Acme Roller Chain Drives are inherently dependable for efficient and economical transmission of power. In contrast with other types of power transmission media, roller chain drives have the following advantages.

POSITIVENESS

The driven sprocket turns at a speed that is exactly proportionate to the speed of the driver sprocket. They operate without slippage or creep, and are unaffected by most atmospheric conditions.

EFFICIENCY

Acme Chain Drives deliver over 98% of the power furnished by the driving sprocket to the driven sprocket. There is practically no loss in the ratio of energy between driving and driven members. Compare this efficiency with other types of power transmissions.

ECONOMY

The initial cost of Acme Chain Drives is comparable and in many instances less than other types of power transmission and life expectancy is longer.

Power consumption is less when you use ACME ROLLER CHAINS. When necessary, repairs can be quickly effected with standard repair parts.

Be sure you ask for ACME Roller Chains. Available nationally through your local Industrial Distributor.

Write Dept. 28-C for new 100-page illustrated catalog, including new engineering section showing 36 methods of chain adjustments.

Call ACME for Service

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

For more information circle No. 2 on the Reader Servcie Card

Continued from preceding page

Booth 1143—*Ferguson Machine Corp., St. Louis, Mo.*

High-speed indexing

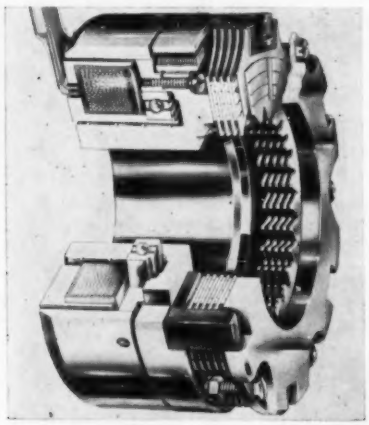
Precision indexing mechanisms capable of operation at speeds to 2,000 indexes per minute. Roller gear drive device uses a cam with tapered rib and ball or roller bearing followers for positive locking and zero backlash at all times. Indexing accuracy within .001 in. for minimum of 8,000 hr operation without maintenance. Motor units contain built-in clutch-brakes. Brake engagement stops power output while rotor continues at top speed, storing energy. Impulse loads to 10 times rated value of motor can be accommodated. Stock motors from ½ to 5 hp.

Circle number 233 on reader service card

Booth 1150—*Fawick Airflex Div., Fawick Corp., Cleveland, Ohio.*

Magnetic clutches, brakes

Compact precision units operate with high speed and torque. Mechanical parts separated from electrical sys-



tem for faster engagement and disengagement, and less wear. No clutch "drag" due to residual magnetism. Outside diameters 2-⅜ to 13-¼ in.

Circle number 234 on reader service card

Booth 1152—*McCauley Industrial Corp., Dayton, Ohio.*

Multiple disc clutch

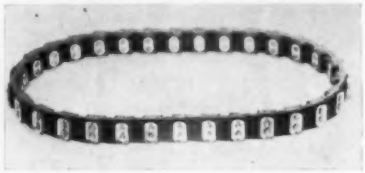
Electro-magnetic. Magnetic flux does not pass through disc stack. Discs free from residual magnetism, idle torque minimized, heat developed greatly reduced. Assembled with 1 or 2 slip rings for both wet and dry applications. 5 models in 15 sizes.

Circle number 235 on reader service card

Booth 1158—*Manheim Mfg. and Belting Co., Manheim, Pa.*

Variable-speed belt

Belts eliminate need for special sizes for machines. Link design adjusts to any length for various size drives.



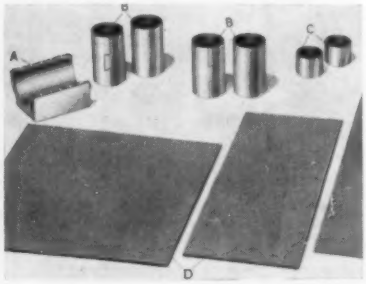
Made of oil and heat-resistant neoprene, precision balanced to eliminate vibration. Drive unit need not be disassembled. Belt widths from 1½ to 5 in.

Circle number 236 on reader service card

Booth 1159—*Dixon Corp., Bristol, R. I.*

Bearing liners

T-liner bearings have thin inner lining of Rulon ("super" Teflon). Expands or contracts around metal sleeve without changing inside diameter of bearing. For high temperature applications to 500 F without lubrication. Loads and speeds to 10,000 pv. S-liners are fine wire mesh spray-coated with Rulon for greater heat



dissipation; pv values to 20,000. F-liner bearings lined with spun Teflon cloth on steel backing for up to 80,000 psi.

Circle number 237 on reader service card

Booth 1201—*Auburn Mfg. Co., Middletown, Conn.*

Packings and seals

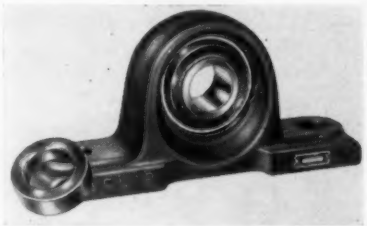
Light or medium gauges Plastiflex. Unaffected by most chemical reagents. Impervious to oils or grease at highest temperatures. Withstands long use, high torque loads. Color-coded thicknesses make assembly easier.

Circle number 238 on reader service card

Booth 1236—*Fafnir Bearing Co., New Britain, Conn.*

Pillow blocks

New standard series pillow blocks and bearing units. Unrestricted self-alignment of blocks in any direction. Wide inner ring ball bearings in-

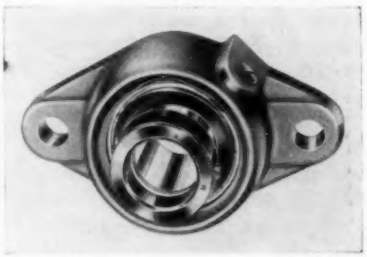


corporate frictionless Mechani-Seals. Relubricatable styles also available. Complete line all styles for any dimensional need.

Circle number 239 on reader service card

Flange ball bearing mount

Flange cartridge mounts for use in confined spaces. Inner ring self-aligning in any position for shaft diame-



ters from ½ to 1-15/16". 2 bolts on housing flange in place of conventional 4. Mechani- or Plya-sealed for contamination protection. Prelubricated or with grease fitting for relubrication. Radial load capacities from 345 to 1150 lb at 5000 rpm.

Circle number 240 on reader service card

Booth 1210—*Charles Bond Co., Philadelphia, Pa.*

Stock gear line

All styles and specifications in steel, cast iron and special-material gears for Class I service operation. Also speed reducers, sprockets and chains, couplings.

Circle number 241 on reader service card

Booth 1238—*Brook Motor Corp., Chicago, Ill.*

Rerate motors

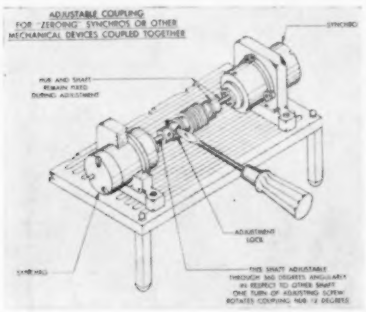
Open drip-proof and totally enclosed fan-cooled rerate ac motors. Smaller than standard frame models, with weight saving up to 11% of conventional motors with same output.

Circle number 242 on reader service card

Booth 1259—*PIC Design Corp., East Rockaway, N. Y.*

Adjustable couplings

New type "zero adjustable" coupling provides precision rotational angular adjustment between two synchro rotors or other mechanisms requiring angular displacement. Eliminates



need for rotating synchro to "zero in" with its companion. One turn of the coupling rotates one coupled shaft in respect to the other through only 12 deg. Another feature is continuous rotational adjustment through 360 deg, either direction. Coupling length 1.862 in., diameter 51/64 in.

Circle number 243 on reader service card

Precision grooved pulleys

Precision stainless steel pulleys in 3 basic shaft sizes: 1/8, 3/16 and 1/4 in. Outside diameters from ½ to 2 in. for wide variety of drives.

Circle number 244 on reader service card

Continued on next page

Grip-Master® SPROCKETS

LOW INITIAL COST—Standard bore sizes with keyways and setscrews eliminate machining. Over 400 sprocket sizes available.
LONGER LIFE—All steel sprockets up to 7" in diameter have hardened teeth for long life.
LOWER REPLACEMENT COST—Save 30%, hubs and bushings are reusable. Easy maintenance reduces production down time.

If high chain drive costs are your problem—write today for Catalog 200A, the way to save.

cullman

WHEEL COMPANY

1352 Altgeld Street, Chicago 14, Illinois

ROLLER CHAIN DRIVES SINCE 1893

Representatives and Distributors in all Principal Cities

For more information circle No. 37 on the Reader Service Card

Continued from preceding page

Booth 1256—*Winsmith, Inc., Springville, N. Y.*

Single and double reduction units

Shaft-mounted worm-gear speed reducers, flange-mounted and torque-arm styles in single- and double-reduction series. Single reduction series: 3 sizes each style, 0.63 to 8.82 hp, 7½:1 to 77:1 ratio range, maximum output torque range 816 to 7678 in-lbs. Double reduction series: 3 series each style, 0.041 to 2.552 hp, 66-2/3:1 to 4466:1 ratio range, maximum output torque range 1380 to 7678 in.-lbs.

Circle number 245 on reader service card

Booth 1402—*Atlas Chain and Mfg. Co., West Pittston, Pa.*

Chain link innovation

For easy roller chain disassembly. Identa-Links mark spot where chain is to be disconnected, and identify by color the type of link involved. Now used in company's single and double chain, and available as replacements on installed drives.

Circle number 246 on reader service card

Booths 1436, 1438—*Syntron Co., Homer City, Pa.*

Shaft-seals

Syntron mechanical shaft-seals eliminate gas or liquid leakage around rotating shafts of compressors, turbines, engines, etc. All moving parts, rotating with the shaft, are within the housing so that shafts never wear. Seals include self-adjusting pressure balance which adjusts pressure between sealing surfaces as gas or liquid pressure changes. Standard shaft-seal handles abrasive-free liquids at pressures from 0 to 250 psi and shaft speeds from 0 to 3000 rpm.

Circle number 247 on reader service card

Booth 1504—*Lovejoy Flexible Coupling Co., Chicago, Ill.*

Variable-speed pulley

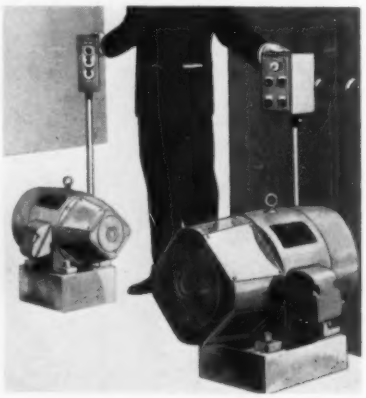
Hi-Ratio variable-speed pulleys give a wide range speed selection with constant-speed motor. Control base adapts to different drive configurations, eliminating need for pivoted motor mount to maintain belt tension. Hi-Lo pulleys automatically adjust to maintain given pitch diameter setting (hence speed) under large load variations. Allows maximum efficiency under varying production schedule conditions. Three styles for use with motors up to ½, ¾ and 1 hp.

Circle number 248 on reader service card

Booth 1443—*Cutler-Hammer Inc., Milwaukee, Wis.*

Packaged drives

New line of adjustable-speed dc packaged drives for static power conversion. Units replace conventional



motor-generator sets with savings in cost, weight and space used. Ultraflex E, 1 to 40-hp electronic drive. Ultraflex M, 1 to 200-hp magnetic amplifier drive.

Circle number 249 on reader service card

Booths 1513-1523—*Eaton Mfg. Co., Kenosha, Wis.*

Fractional HP drives

Adjusto-Spede models with stationary field coils eliminate slip rings, brushes, commutator. Control features for inching, precise speed adjustment and control, with optional control features available. Several lines for various hp ranges, mounting positions, etc. Models ACM 903,904 offer 20 ratings from ½ hp at 8000 rpm to 7½ hp at 3400 rpm. Eddy-current or Dyna-TorQ friction-type brakes.

Circle number 250 on reader service card

Booth 1531—*Maurey Mfg. Corp., Chicago, Ill.*

V-drive sheaves

Machined from close-grained, semi-steel castings and precision balanced for smooth, belt-saving performance. Ful-Grip sheaves have tapered bores and matching one-piece, flanged and split detachable hubs. Speed adjustable by changing sheave, shaft size fit adjustable by changing hub.

Circle number 251 on reader service card

Booth 1553, 1555—*Raybestos-Manhattan, Inc., Passaic, N. J.*

Poly-V drives

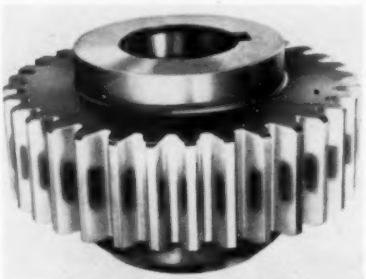
Single-unit, V-ribbed belt has uniform, unbroken strength across full width of sheave. Eliminates matching problems, delivers up to 50% more power in same space as multiple-belt drive. Belt position stays constant, avoids deforming of grooves and wear. 2 series (belt) weights in all standard pitch lengths.

Circle number 252 on reader service card

Booth 1548—*Sier-Bath Gear & Pump Co., Inc., North Bergen, N. J.*

Case-hardened gears

Newly-introduced crown-ground case-hardened spur and helical gears minimize damage from misalignment,



shaft deflection and tooth distortion. Improved gears offer wider design latitude toward goals of more power and higher speeds.

Circle number 253 on reader service card

Booth 1620—*Amplex Div., Chrysler Corp., Detroit, Mich.*

Sintered bearings

Iron Oilite 212 bearings, made chiefly of iron powders, replace more ex-

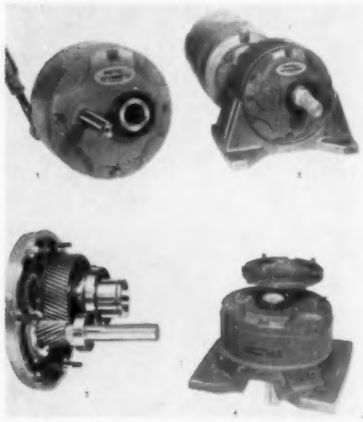
pensive porous bronze bearings for many uses where corrosion is not a problem and normal strength requirements are present. Specially suited for oscillating and reciprocating motion.

Circle number 254 on reader service card

Booth 1638—*Boston Gear Works, Quincy, Mass.*

Helical-geared speed reducers

Optimount helical-geared speed reducers may be used in wide variety



of mounting positions: directly on horizontal or vertical drive shafts, or base mounted in any position. Output 10 to 431 rpm; 1/6 to 15 hp.

Circle number 255 on reader service card

Booth 1653—*American Sealants Co., Hartford, Conn.*

Liquid sealant

Loctite sealant preserves worn bearings in use by filling in excess clearance. Also allows parts to be fitted by hand with subsequent securing for faster production.

Circle number 256 on reader service card

Continued on next page

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HI . . . in capacity — will handle up to double the load.

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HI-Line reducers are available in six new series ranging from 1.33″ to 5.25″ centerdistance. Standard models in each series include vertical with high or low base, and horizontal models with worm upper or lower.

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Ohio OHIO GEAR Company

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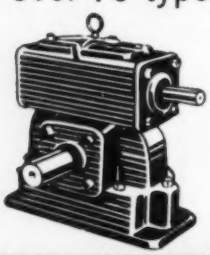

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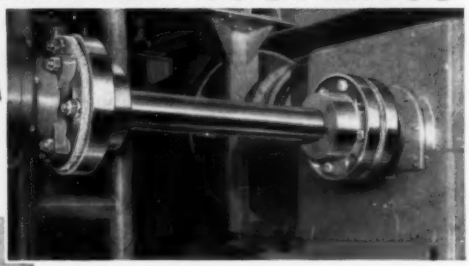

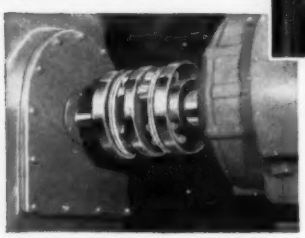

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For more information circle No. 28 on the Reader Service Card

Continued from preceding page

Booth 1651—*Stow Mfg. Co., Binghamton, N. Y.*

Flexible shaft coupling

Flexible shaft core of tight-wound music wire with terminals at each

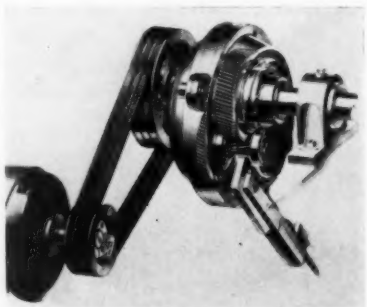
end. Eliminates close alignment problems and allows rotational movement of coupling at either end. Shaft cores from 3/16 to 1-¼ in., terminals for any need.

Circle number 257 on reader service card

Booth 1646—*The American Pulley Co., Philadelphia, Pa.*

Shaft-mounted speed reducers

Shaft-King drives include compact reduction gear units that mount on shaft extension by means of keyed, tapered bushing. Short-center V-belt from input shaft of unit to motors.



7 sizes from ¼ to 42 hp in ratios 13:1 and 20:1. Also in 4 sizes from ¼ to 25 hp in 5:1 ratio.

Circle number 258 on reader service card

Adjustable-speed drives

Companion adjustable sheaves and Wedgbelts for speed variations to 2 to 1. Belts are arched to avoid center sagging. Pitch diameter ranges from 3.5 to 36 in.

Circle number 259 on reader service card

Continued on page 56

INCREASED SPEEDS

continued from page 25

air motors and compressors, would be limited only by some function of the bursting strength of the rotor.

Laboratory applications of 25 years ago produced rotative speeds of 21,600 rps or nearly 130,000 rpm. Some industrial rotative speeds are now at this level and increasing.

Any advance in science or engineering raises these problems. If we suppose that machine efficiency remains constant with increased rotative speeds, then the losses generated within the machine must be dissipated from a smaller volume. Increased thermal loading requires more adequate cooling. Higher rotative speeds mean more windage loss. This places additional importance on proper bearing design.

Bearings generate heat within themselves because of the shearing action of the fluid film. As speeds increase, the heat loss increases which can cause bearing failure due to a breakdown of the bearing lubricant. One way of reducing heat is to change from a liquid lubricant to either gas or oil-mist.

Gas-Lubricated Bearings

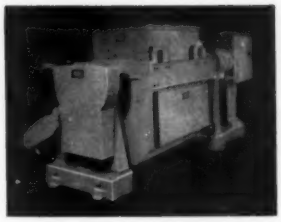
Some of the problems introduced by gas-lubricant bearings would be rotor stability, cleanliness, shaft alignment, or load carrying capacity. The use of a gas as a bearing lubricant reduces heat generation, but at the same time permits higher bearing temperatures since gases do not break down at moderate temperatures. Another advantage offered by gas lubrication is the absence of contamination from the lubricant.

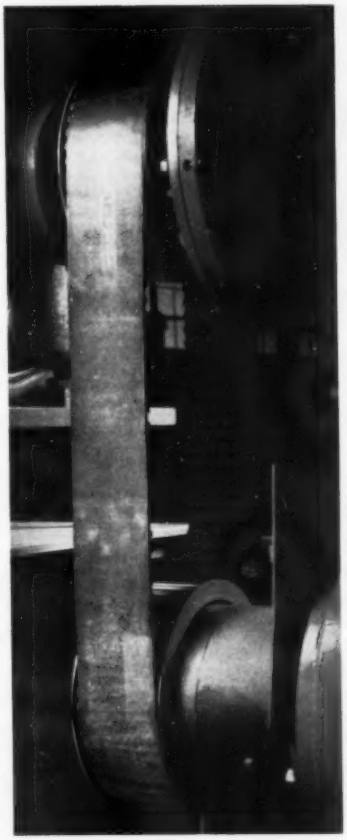
Gas-filled bearings center themselves, not because of the oil-wedge, but by the static pressure forces set up by proper design. By the use of clean gas supplied to the bearing, maintenance can be very small. Reports show that no maintenance is needed for bearings operating several thousand hours. Oil mist and moisture have not been found to be a difficulty if the bearing or journals are not attacked.

Bursting Speed

With high rotative speeds, it is necessary to be very certain of rotor soundness. The upper speed limit in some applications is the bursting

Continued on page 55





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The slip-free, positive action and absence of belt stretch in Wood's Timing Belt Drives fills these needs month-in and month-out in 'round-the-clock service. These compact drives not only satisfy the ruggedness and high efficiency requirements of this application, but have long life and eliminate maintenance and matching of belts. Having no metal-to-metal contact, they require no lubrication. These features permit the use of this drive in cramped, relatively inaccessible areas.

Wood's Timing Belt Drives have a wide range of load capacities, up to 600 hp and above, and cover an exceptional speed range, from zero to 16,000 fpm. They offer outstanding solutions to a wide variety of drive problems.

For complete information and your copy of Catalog 2100, contact your T. B. Wood's distributor.

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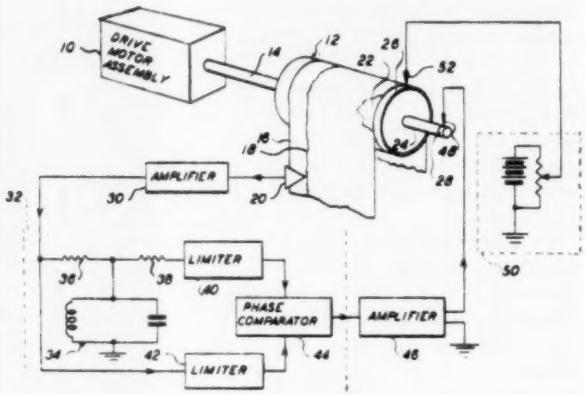
PATENTS

Speed Control

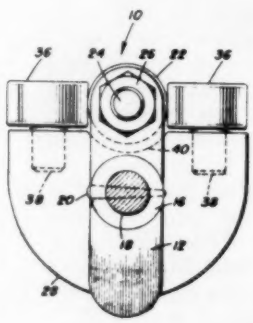
U. S. Patent 2,867,436; Theodore Miller, Los Angeles, Calif., assignor by mesne assignments to Consolidated Electrodynamics Corp., Pasadena, Calif.



In a tape transport mechanism, speed of the tape is varied by electrically varying the diameter of the driving drum. This is done by covering the outer surface of the drum with at least one layer of electrostrictive material which changes in thickness as the current or voltage applied is changed.

Universal Joint

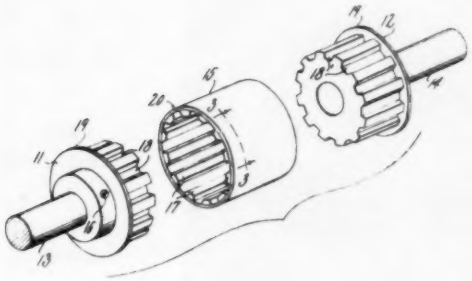
U. S. Patent 2,867,101; John C. Case, Baltimore, Md.



Universal joint is made up of U-shaped yoke fastened to one shaft with a roller at each end of the yoke and a crank arm on the other shaft with a roller at its outer end. The roller on the crank end contacts at least one of the rollers on the yoke to transmit motion between the two shafts.

Resilient Shaft Coupling

U. S. Patent 2,859,599: Richard Y. Case, Philadelphia, Pa., assignor to United States Rubber Co., New York, N. Y.



A silent shaft coupling made up of a pair of hubs designed to mount on the shafts to be joined and a coupling sleeve to connect the hubs. Hubs and sleeve have mating grooves for transmitting torque. The resilient sleeve is made up of a resilient flexible core with a bonded fabric cover all bonded to the inside of a thin, flexible, load-carrying band.

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ZERO-MAX gives you the speed you need for finer finishes, quicker, more accurate positioning and longer blade, cutter, band and wheel life. This infinitely variable speed control is smoother and quieter than most other original power equipment. By merely moving a lever, you can change speed or direction at any time, running or not. Speeds from zero to 400 rpm—torque up to 100 inch-pounds. With or without motor, and with gearheads for multiplying speed range or torque up to 4½ times. What's your rpm problem? *Write for fully illustrated 16 page catalog.*

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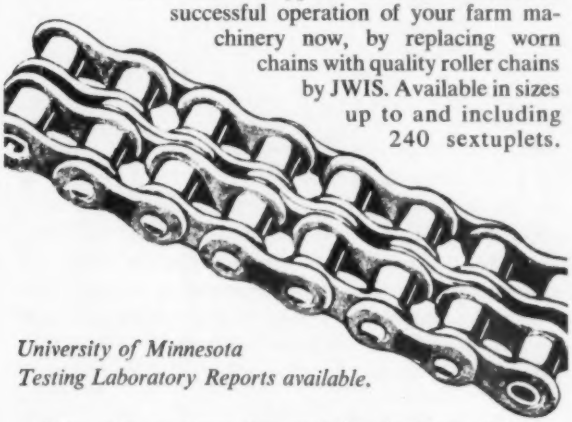

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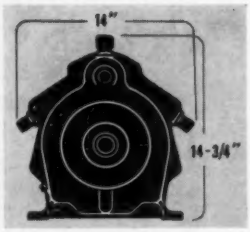
more versatility for your power team

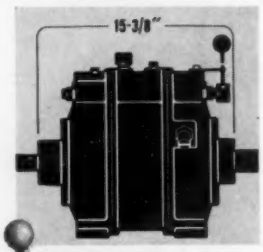
NEW

S-N MODEL 5231

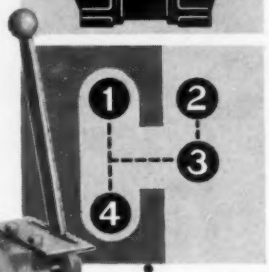
5 in 1

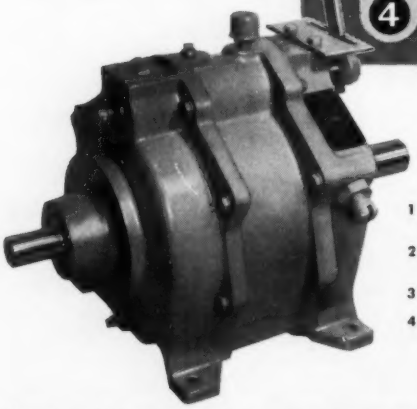
REVERSING TRANSMISSION





Combines 2 speeds forward, neutral, reverse, and reduction into a single compact unit that reverses under full load.





1 FORWARD 3.34 Reduction
2 FORWARD 1.97 Reduction
3 NEUTRAL
4 REVERSE 3.37 Reduction

Here is really good news to power transmission engineers. This new brother to the widely used S-N Reversing Transmissions adds a second forward speed for greater versatility and added power transmission efficiency. New Model 5231 offers limitless possibilities in the design or redesign of agricultural, material handling, machine tool and construction equipment. Write now for full information and literature to The Snow-Nabstedt Gear Corporation, Hamden, Conn.

SPECIFICATIONS MODEL 5231

- Reduction Ratio—1.97:1 and 3.34:1 Forward; 3.37:1 Reverse
- Power Transmission—up to 28 HP
- Maximum input torque—1000 pound inches
- Maximum input speed—2000 RPM
- Dimensions—15 1/16" long, 14" wide, 14 3/4" high
- Includes built-in clutches for reversing under load

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Transmission Engineers
FOR OVER HALF A CENTURY

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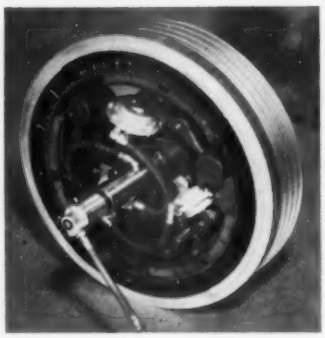
HORTON
VARIABLE SPEED CLUTCH PULLEYS



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Minneapolis 14, Minnesota

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SHAFT MOTION INDICATOR

Connects to rotating shaft

Actuates warning lights or other signals. Operates control switches.

PROVIDES positive indication of drop in speed or stopping of machinery
PROTECTS conveyors • elevators • feeders • belt conveyors
OPERATING SPEEDS of 10 to 150 rpm make the **ROTO-GUARD** applicable to automatic protection of slow-moving machinery used in material handling and similar systems
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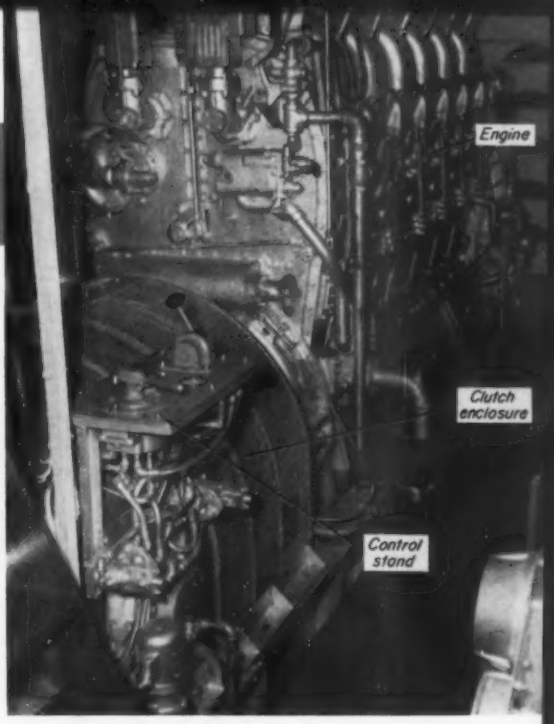
IDEAS *for designers and plant engineers*

Air-cooled clutch dissipates heat during drive reversal



CLUTCH ENCLOSURE of expanded metal allows free-flow of air for cooling. This photo, in the tug's engine room, shows the engine-room control station and engine as well as the clutch enclosure.

AIR-OPERATED CLUTCH on the tug *Rhode Island* couples the engine to a reversing marine gear box, gives fast reversing and slow-speed control. Horsepower involved is 1200 at 750 rpm.

AN AIR-COOLED CLUTCH dissipates tremendous amounts of power during propellor reversal and at speeds below engine idle on a tugboat. Since idle speed is 90 rpm and the propellor must turn at speeds corresponding to slower than engine idle speed for delicate maneuvering, the clutch slips to give speed control down to 20% of propellor rpm.

Quick reversing and precise speed control are essential for maneuvering a tugboat in busy harbors. When 1200 hp at 750 rpm is involved, the clutch engages and disengages the reversing gear box from full speed ahead to full speed astern in 7 to 9 seconds. Many other drives were tried before this one was selected for the best job from performance and economy standpoints.

The clutch assembly is made up of two separate units. One drives the *forward* input shaft of the reversing gear box; the other drives the *astern* bevel gear. The driving disc is supported between the two driven discs, by an adapter and an air tube support plate. The air tube support plate for the astern clutch is fastened to the other side of the driving disc. One clutch or the other is engaged by applying air pressure to the appropriate air tube. This expands the tube to force the pressure plate and driven disc into contact with the driving disc. Air pressure applied determines torque capacity of the clutch.

Both the driven plates and the pressure plates have passages in them for cooling air circulation. These passages let the plates function as centrifugal blowers to give high air flow. The entire assembly is housed in an expanded metal enclosure. This gives adequate

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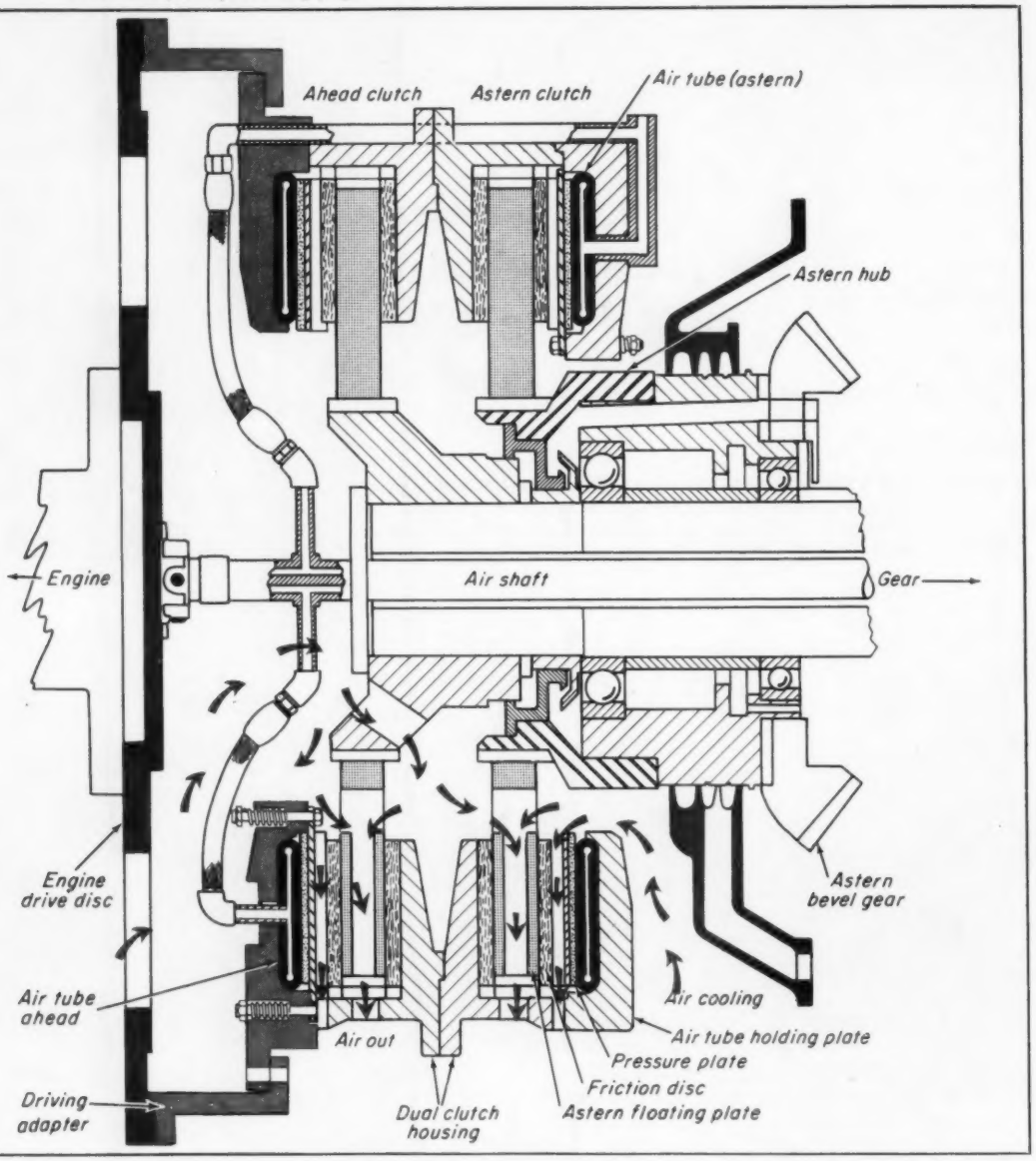


CLUTCH, IN SECTION, shows cooling air passages in the clutch plates, drive connections, and air tubes for engaging the plates.

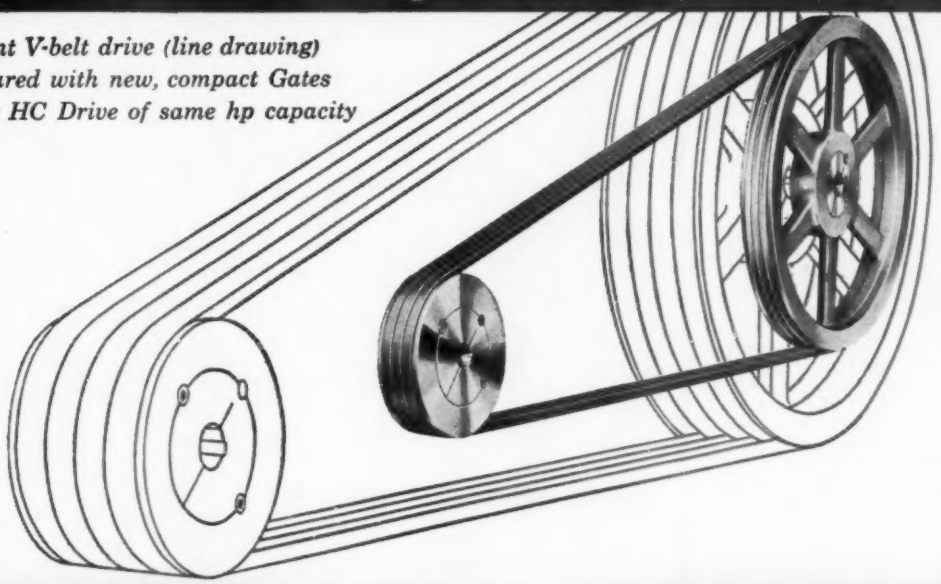
protection and does not restrict air flow.

A single lever controls the clutches and the engine throttle. The lever is moved forward for forward travel and back for reverse. During the initial third of lever travel, the lever selects the clutch to be engaged and applies gradually increasing pressure to the air tube. This gradually increases torque capacity of the clutch and thus gradually reduces slipping and increases propellor rpm. As the 1/3 travel position is reached, air pressure has increased to the point where full torque capacity of the clutch is reached. Also, air pressure reaches a high enough value to move the pneumatic actuator at the engine governor and move the governor speed-setting lever away from idle. Continued movement of the lever then increases engine speed to give speeds up to maximum. This air control system is used by The Great Lakes Towing Co., Cleveland, Ohio.

It is a development of *Robert R. King Co.*, Lakewood, Ohio.

up to 50% LESS SPACE needed for revolutionary new V-belt drive

Present V-belt drive (line drawing) compared with new, compact Gates Super HC Drive of same hp capacity



COMPARE: Left, typical drive with present V-belts. Right—drive of same hp capacity with Gates new Super HC V-Belts . . . uses fewer belts, smaller sheaves and shorter center distance.

Exclusive cross-section design: The precisely engineered arched top, concave sidewalls (U. S. Pat. 1813698) and special tensile construction insure full pulling power and longer belt life.

Reduces drive cost as much as 20%

A major advance in the field of power transmission, the fully proved Gates Super HC V-Belt, makes possible the lowest-cost, lightest-weight, most compact multiple V-belt drive that can be put on any machine!

The cost of a new Gates Super HC V-Belt Drive is as much as 20% less than present V-belt drives of the same hp capacity.

For detailed information on the Super HC Drive, contact your nearby Gates distributor or Gates Office for new booklet, "*The Modern Way to Design Multiple V-Belt Drives.*"

TPA 389

The Gates Rubber Company, Denver, Colorado

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Gates Super HC V-Belt Drives

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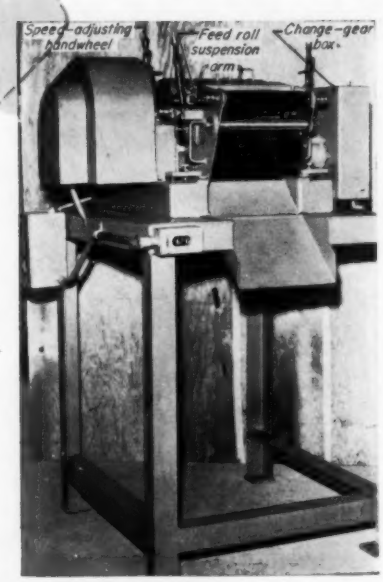
INCREASED TOOTH ADDENDUM AND DEDENDUM lets adequate tooth contact be maintained when feed rolls separate.



PLASTIC PELLETIZER will produce three different pellet lengths and has wide speed variation.

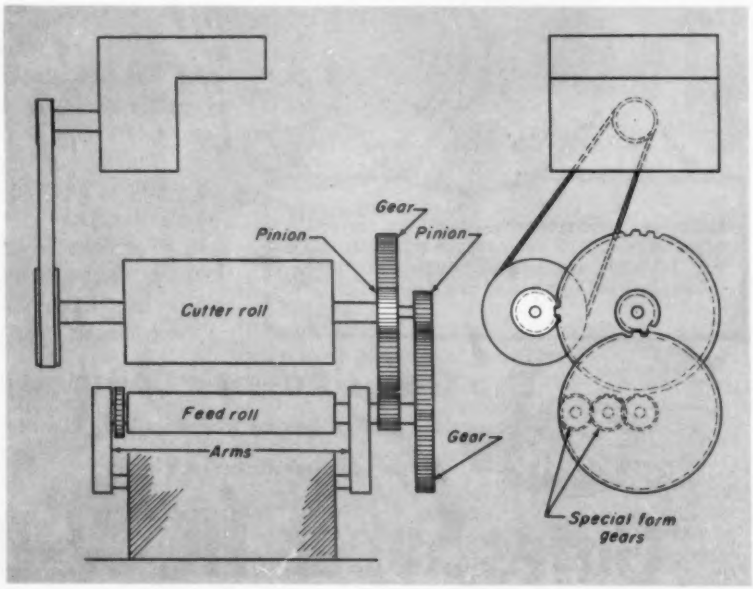
Special-form gears permit center distance change

SPECIAL TOOTH FORM lets the feed rolls on a plastic pelletizer separate by as much as — in. to allow for changes in material thickness. The upper roll is mounted on spring-loaded arms to let it move up or down as thickness of the plastic rod being fed varies.

The drive train starts with a variable-pitch pulley, adjustable-speed unit. This unit is adjusted by a handwheel and gives output speeds of 475 to 3200 rpm. This drives the cutter roll. At the opposite end of the cutter roll, a double spur-gear reduction box gives reductions of 8:1, 11:1, or 18:1. These are change gears. Output of these gears drives the feed rolls. Pellet length is determined by the change gear ratio.

A standard-form spur gear on the output shaft of the gear box drives the special-form gear on the lower feed roll. This meshes with an identical special-form gear on the upper roll. Departure of these gears from standard tooth form are: increases in addendum and dedendum to give the form shown. In general, gears used in this way are 14-½ deg pressure angle. Increase in center distance should be limited so that 60 to 70% tooth contact is maintained.

This machine is a product of Alsteele Engineering Works Inc., Framingham, Mass.



DRIVE TRAIN of the plastic pelletizer. Special-form gears allow feed roll separation.

Oil-path change stops bearing freeze-up at 450°F

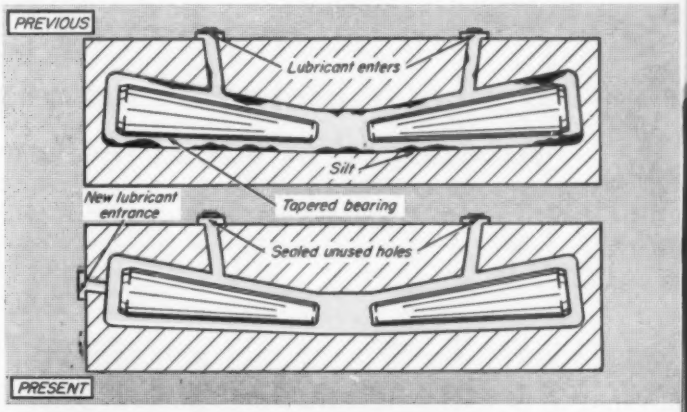
TAPERED BEARING lubrication paths, redesigned for horizontal flow, removed bearing freeze-up occurring at high temperature on a plastic film drying drum. Engineers drilled a hole, entering the chamber from the end through the side of the housing. This assured entry of a sufficient amount of grease, getting it into the specific point of frictional heat buildup.

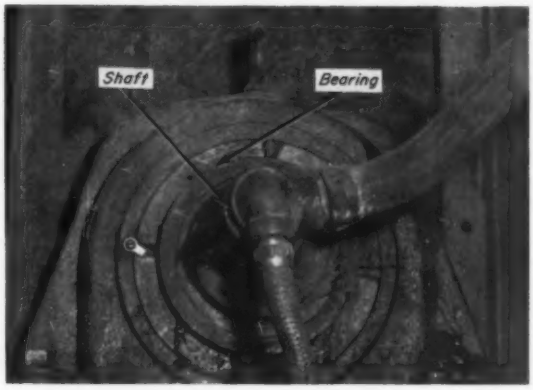
Originally the problem was that grease used on the bearings would dry out under effects of the oven temperature of 450°F. As the grease lost its oil base, filler cemented the bearings together and plugged lubricating holes.

Twenty-four hours downtime and the idling of six men resulted when bearings were re-opened and replaced. Roller supported by the bearings is 36 inches in diameter and is 66 inches wide.

Thrust load on these bearings is 35,000 lbs. The stainless steel belt turned on the roller is 200 feet long and weighs 1200 lbs. Speed varies from 8 fpm to 25 fpm.

This high-temperature bearing-lubrication design was originated and is now functioning in the plant of *Flex-O-Glass, Inc.*, Chicago, Ill.





BEARING is seen in cross section in drawings at right. Frozen bearing is seen at top with cement adhering to walls and roller. Healthy bearing is below. New lubrication entry is seen at left of drawing. Photo shows bearing, shaft-end, and roller.

Variable speed reducer cuts scrap losses

VARIABLE SPEED REDUCER slows machine action so as to give operator complete control over blanking and drawing operations on a press.

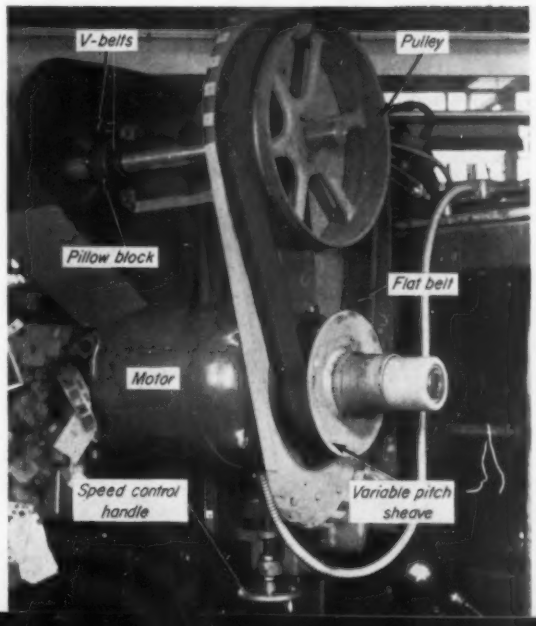
Problem once was: How to slow press down from 900 rpm which meant 125 strokes per minute, too fast for drawing operations. Scrap ran 20%.

Solution is: Install variable-pitch speed reducer. Strokes are regulated from 26 to 74 per minute, rpm is now 875, reduction ratio is 1:1 and 1:4.

Reducer powers 10-inch diameter pulley with 2½-inch-wide belt. The pulley turns a shaft 2½-inches in diameter, powering 30-inch diameter fly-wheel gear.

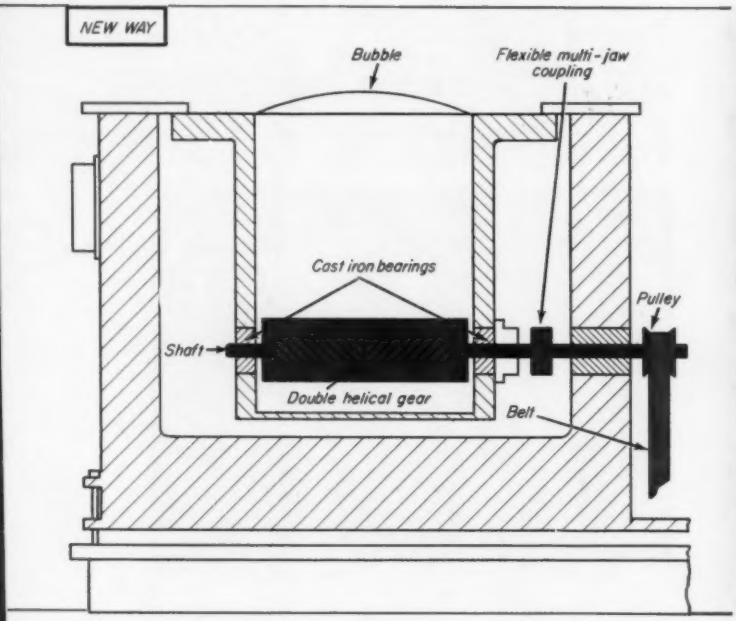
Motor is 7.5-hp, 3 phase, 60 cycle, 220-440 volt, 875 rpm, 23-11.5 amps.

This application is used in the *Stewart-Warner Electronics Division of the Stewart-Warner Corp.*, Chicago, Ill.

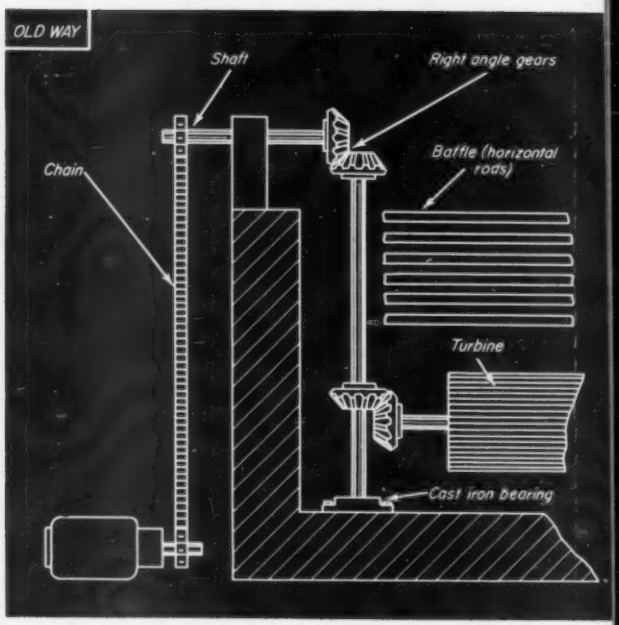


VARIABLE PITCH SHEAVE is seen at right, as it controls press-operation speed for blanking.

Double helical gears act as positive pump submerged in vat of molten solder



HELICAL GEARS act as efficient positive pump.



RIGHT ANGLE GEARS and turbine made uneven bubble.

HELICAL GEAR-PAIR submerged in molten solder, acts as a positive pump in printed circuit production for electronic units.

Formerly a series of right-angle gears with shafts powered by chain and sprocket turned a turbine submerged in the molten metal.

Early testing showed this was not satisfactory as the turbine action did not keep upper level of solder constant. Boards being printed with circuits were passed over the solder but were not able to be completely covered.

Dross accumulated on top of the solder-pot, stopping solder operations. The problem was getting the solder to adhere to the printed circuit, and do it in an easy, economical way without dross interfering.

The turbine was stainless steel, squirrel-cage, and 5-inches in diameter, 10-inches long. Powering it was a variable speed reducer with 150-175 rpm connected by a two-foot chain to a sprocket at 1:1 ratio, which drove a shaft. The shaft turned a right-angle gear, driving a vertical shaft. This powered the turbine by means of a second right-angle gear. Stainless steel shafts, gears and cast iron bearings were used.

But preliminary tests failed because it was not possible to produce a smooth bubble of molten solder so as to achieve complete contact with the surface being printed. A baffle was needed.

A series of baffles made of horizontal rods were designed and installed above the rotating turbine. All were submerged in molten solder.

This could not function because the rods needed cleaning as often as six times a day. The wave of metal could not be kept at a uniform level by the gear-driven turbine.

Solution is the positive displacement pump made up of the pair of double helical gears and driven by the shaft. This shaft comes through the end of the housing wall, eliminating any need for right-angle gears, chain, and sprockets. A multi-jaw coupling connects shaft and variable speed drive.

Helical gears have 20-degree pressure angle, 14 teeth, diametral pitch of 6, pitch diameter of 2.5-inches, lead of 20.242, helix angle of 21.2-degrees. They are made of meehanite and are 5.875-inches long. The result: A smooth, uniform solder-wave without ripples.

The helical-gear application is the development of *Motorola, Inc.*, Chicago, Ill.

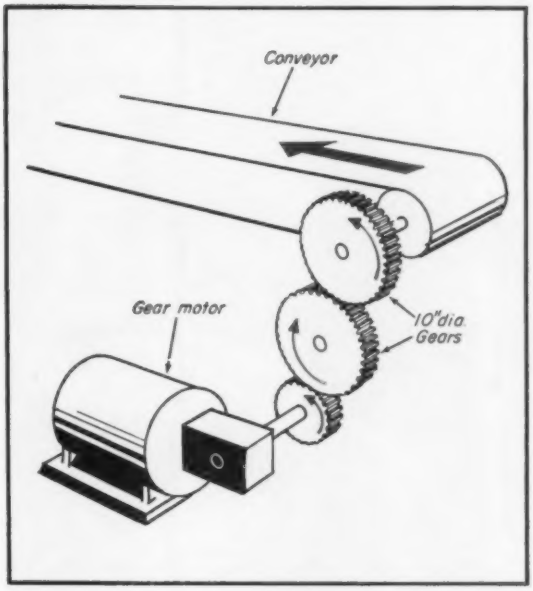
Double-reduction gearing cuts conveyor speed to 3 fpm

GEAR TRAIN is used to gear-down gearmotor output speed to the point where conveyor-belt speed is held at three feet per minute.

Two ten-inch diameter gears are used, one for recovery and the other for speed. A right-angle gear-drive turns a pinion, driving the first 10-inch diameter spur gear. The second driven 10-inch gear turns a friction-pulley which moves the conveyor belt at 3 fpm.

The load on the gearmotor is 50 lbs., output is 8-rpm. The gearmotor is ⅜-hp, 3 phase, a-c, 220 volt. The result of this gear-train application is extreme economy of operation. There have been no maintenance problems and operation has been uninterrupted for a period of approximately three years.

Gear-train application to reduce gearmotor speed is now in operation on the assembly line conveyor in the plant of the *G. M. Laboratories, Inc.*, Chicago, Ill.



GEAR-TRAIN operation moves conveyor belt at 3 fpm.

V-belt and pulleys drive shaft with less horsepower

V-BELT with pulleys cut maintenance costs and use less horsepower to drive an air compressor.

Current was changed from d-c to a-c. The original motor that used to drive the air compressor had 20-hp. It was connected by direct drive to the shaft, turning it at 490 rpm.

Newly installed a-c motor needs less power, has 1200 rpm. Reducing its 1200 rpm to 490 rpm is achieved by using the 10-belt V-drive which is driven by a 10-groove pulley five inches in diameter. This belt drives a second 12-inch diameter pulley. Reduction ratio is 5:12. Center to center distance is 30-inches. The d-c motor formerly used was 20-hp, 220 volt, 490 rpm. The motor now being used is a-c, 15-hp, 208 volt, 60 cycle, 3 phase, 1200 rpm.

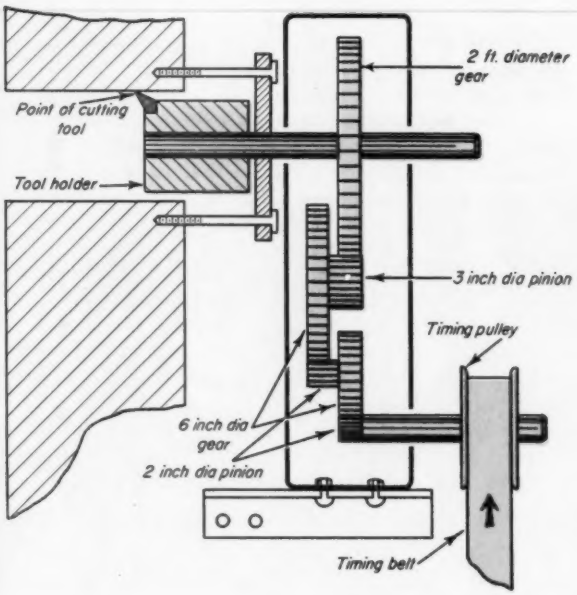
The result of this changeover to the use of V-belts and a-c motor brought other advantages besides the reduction from 20-hp to 15-hp.

Motor and compressor-maintenance costs are reduced. There are no brushes to be replaced at regular intervals. This together with the reduced power-needs, results in an over-all maintenance and power cost-saving of approximately 10%.

The installation of the 10-belt V-drive and pulleys together with the a-c motor, is a power transmission application now operating the air compressor at the *Sherman Hotel*, Chicago, Ill.

V-BELT drives compressor shaft with less horsepower, reduces a-c motor's rpms from 1200 to 490.

Gear train and timing belt



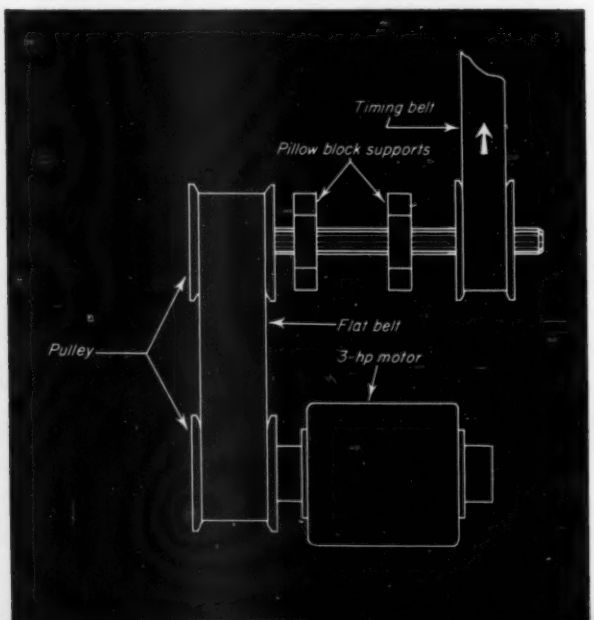
GEAR TRAIN powered by a timing belt makes a boring tool completely portable, doing away with the need for heavy in-plant boring equipment.

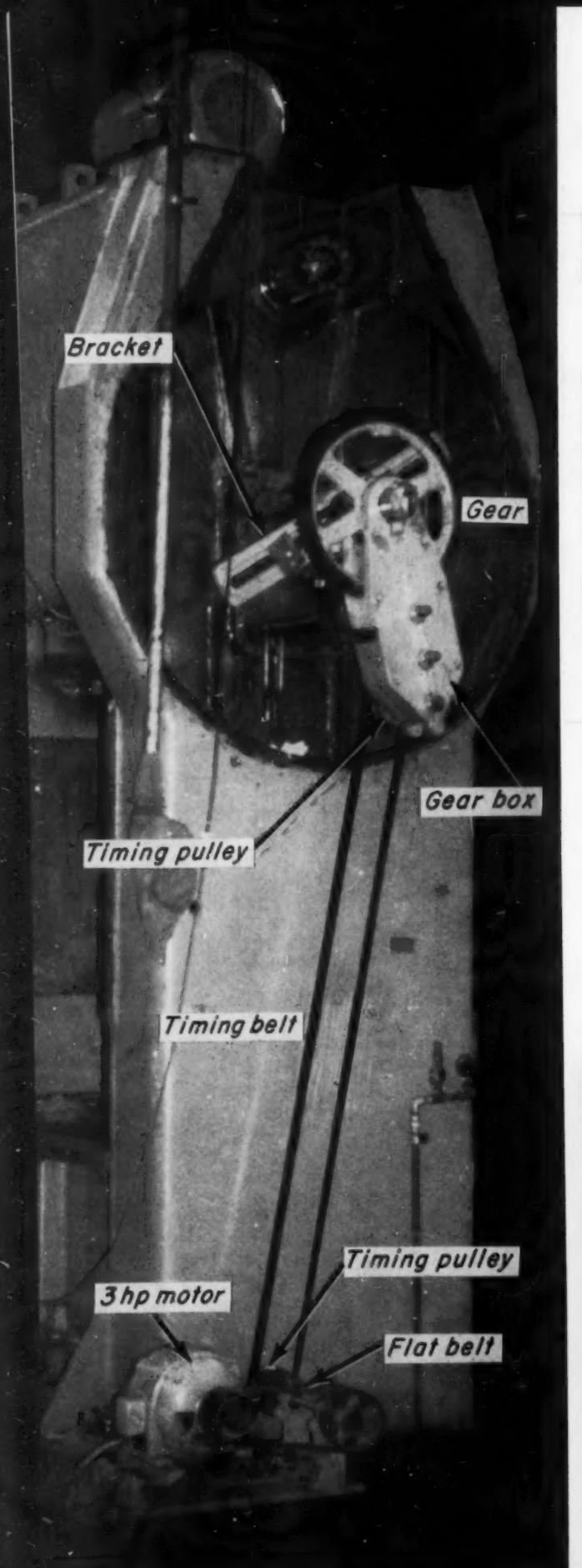
Because the length of the timing belt is adjustable to needs of each job, the gears which operate a shaft-hole boring tool are driven by 3-hp motor located at the base of the machine being repaired.

The driven unit, also completely portable, is pow-

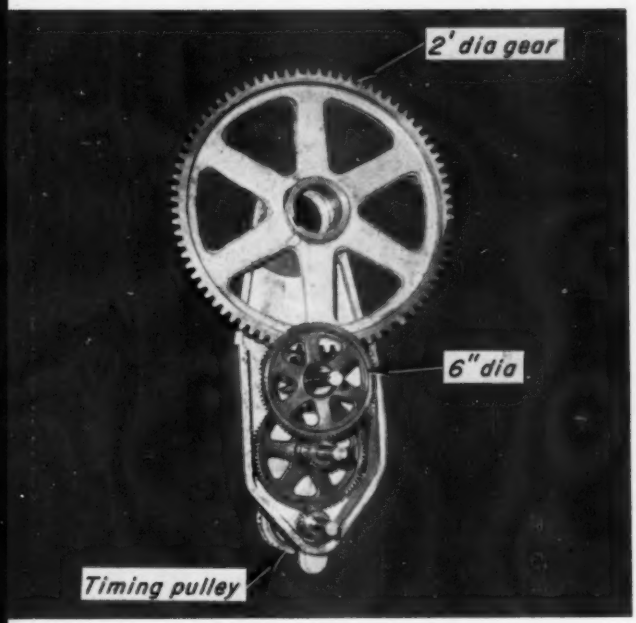
TIMING BELT has adjustable length. It permits use of the unit on machinery of all sizes.

DRIVING UNIT weighs 120 lbs., rests on floor.





make power unit portable



GEARS driven by timing belt, power the shaft which operates the cutting tool and rebores the hole. The large gear which turns the boring-shaft, is 24-inches in diameter. Drawing at far left shows power transmission path through the gear train. Photo at near left shows gears as they appear in position.

ered by a 3-hp, a-c, 60-cycle, 220-440 v, 3600 rpm motor turning a pulley and driving a flat belt three inches wide. Pulley driven by this flat belt operates on a 1:1 ratio with the driver-pulley.

The driven pulley turns a shaft driving a shaft-mounted timing belt pulley. This drives the 2½-inch wide timing belt, delivering power to the gear train mounted above, against the side of the machine rebored.

Designed specifically to reduce speed from 3600 rpm to the low rpm shaft-turning speed, the gear train is composed of three gears and three pinions.

Powered by a timing pulley driven at 3600 rpm by the variable-length timing belt, the train's first driver, a two-inch diameter pinion, drives a gear six inches in diameter. This turns a three-inch diameter pinion which drives the main gear at a low rpm.

This large gear is twenty-four inches in diameter, turns the nine foot, three-inch diameter shaft on which the tool-holder and the boring tool are mounted. An originally designed bracket is mounted on the side of the work itself and acts as a true guide for the shaft on which the boring tool is mounted.

In order to overcome gear-train torque and keep the entire gear-unit from rotating on the boring shaft, an angle iron is bolted to the housing and to the machine being rebored, holding the gear-train rigid.

The motor-unit weighs 120-lb, heavy enough to remain stationary. With this unit, 100-ton machines with holes as big as 27 inches in diameter can be bored without complete dismantling.

The unit is the development of *Precision Machinists, Inc.*, Chicago, Ill.

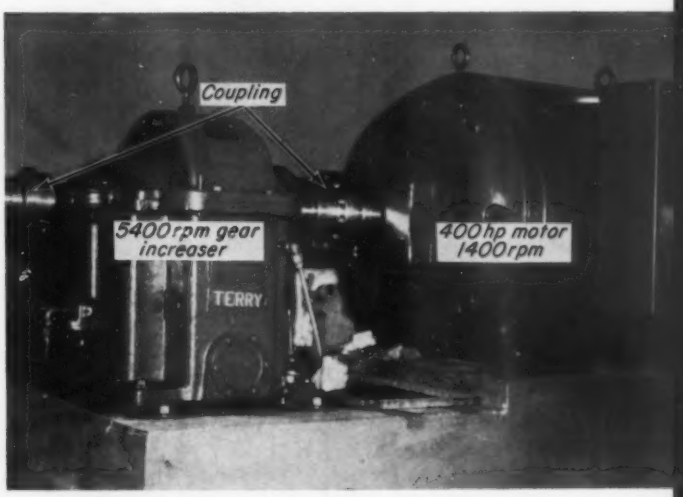
Speed increaser more efficient than large motor

SPEED INCREASER changes low motor-rpm's to those needed for efficient turbine operation in an air conditioning compressor.

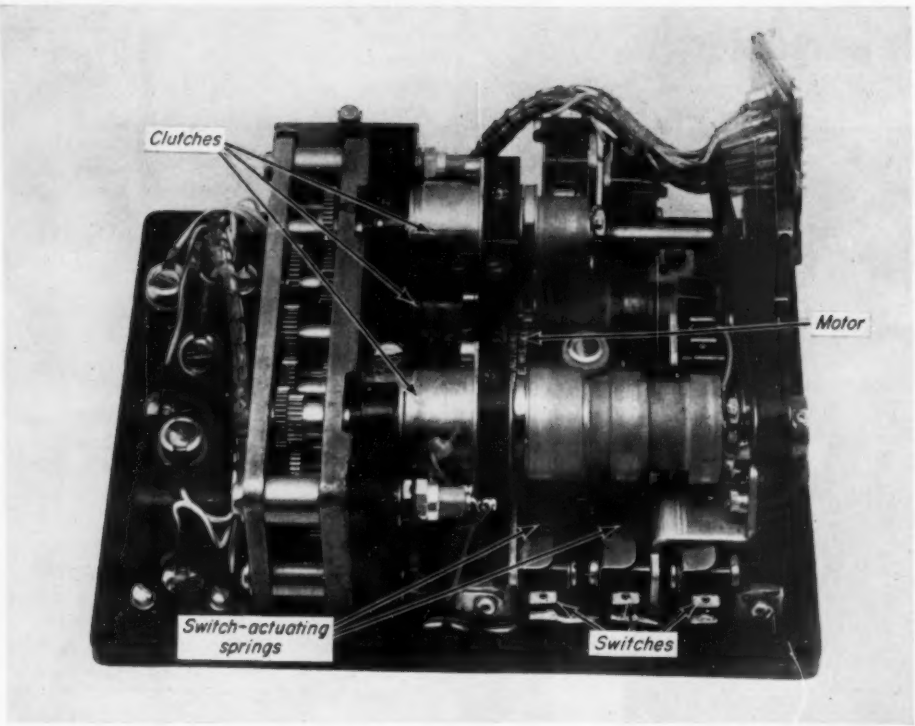
The three-phase, a-c, 208-volt, 400-hp motor has 1750 rpm, not enough to carry off refrigerating gas as fast as it expands from liquid state.

Speed increaser has 1750 rpm input and 5040 rpm output. It has double helical gears and is pressure lubricated. Flexible couplings connect it to the motor and also to the turbine-shaft. Only alternative would be using motor of impractical size and horsepower. By raising the rpm to a useable figure, this situation has been successfully avoided.

The speed increaser is installed in unit operated by *the Lurie Co.*, Chicago, Ill.



SPEED INCREASER steps up rpm's to rate needed in air conditioning compressor, from 1750 to 5040.



AIRBORNE SEQUENCE TIMER uses three electric clutches to time switch-operating cam rotation.

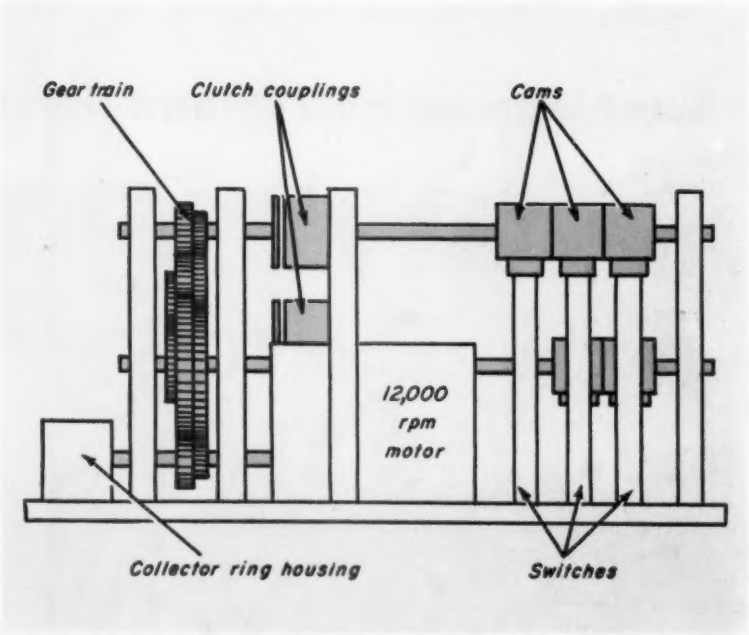
Electric clutches control switch actuation

THREE ELECTRIC CLUTCHES drive cams to actuate the timing switches in an air-to-air missile firing circuit sequence timer. This lets three cams be driven by the same motor through a gear train.

A 12,000 rpm dc motor drives the three cam shafts at 5, 12, and 20 rpm. Motor torque rating is 0.1 oz-in. When a clutch is engaged, the cam rotates 320 deg and then snaps back under spring tension of 4 to 5 oz.

Clutches used were chosen for their ability to stand the repeated impacting in this service as well as their low torque-to-weight, ratio, important in airborne service. Ability to operate at −65 to +275 F is also important. Low current drain of the clutches helps to achieve this, especially when operating near the upper temperature limit.

Avionic Div., John Oster Mfg. Co., Racine, Wis., designed and built this timer.



DRIVE TRAIN DIAGRAM for the airborne sequence timer.

TWIN DRIVES

continued from page 28

leaves the turbine traveling in the opposite direction to the rotation of the pump and turbine. At low turbine speed, that is when the turbine is rotating slower than the converter pump, such as when starting to move the tractor or in heavy pulling, the turbine offers a resistance to turning. Unless the direction of oil flow is changed, oil flowing from the turbine will work against the oil flowing from the pump.

It is during this phase of operation that the stators are used. The stators are free to rotate in the direction of rotation of the pump and turbine, but lock when backward pressure is applied. Oil coming from the turbine exerts a backward pressure on the stators and locks them in place. Oil then flows through the stators, which change its direction of flow and direct it into the converter pump hub.

Drive Shafts

The drive shafts consist of flywheel covers, shafts, drive line and component parts.

The flywheel cover and stub shaft are mounted to the flywheel housing as an integral unit. The stub shaft is splined to a torsion plate in the flywheel and rides in two bearings mounted in the flywheel cover. The outer end of the stub shaft is machined into a flange which is connected to a drive line.

The drive line consists of a rigid, hollow tube mounted to the stub shaft at one end and the transmission input flange at the other end by needle bearings and crosses. The needle bearings and crosses compensate for any misalignment between the stub shaft and transmission input shaft.

A grease tube is connected to the flywheel cover with a grease fitting protruding through the floor plate.

INCREASED SPEEDS

continued from page 41

speed of the rotor. The bursting speed of a solid rotor is a function of the ultimate strength divided by the density. For non-solid or built-up rotors a more conservative estimate should be made. In any case, the housing of the machine should be strong enough to contain the pieces should there be a rotor explosion.

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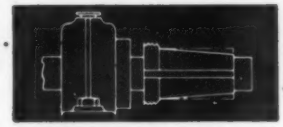

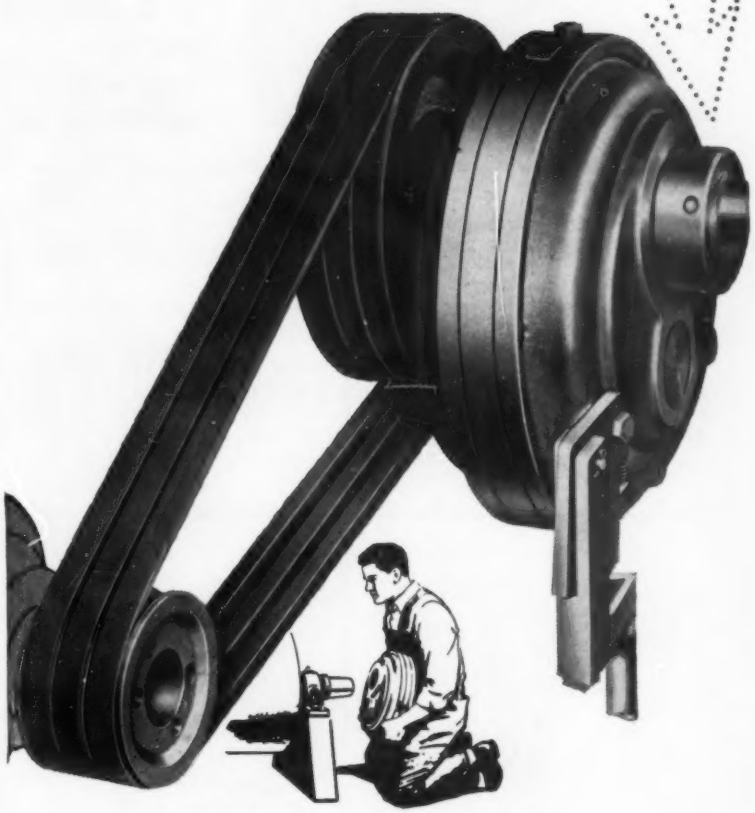

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Continued from page 40

Booth 1108—*Nice Ball Bearing Co., Philadelphia, Pa.*

New ball bearings

Special line designed for farm machinery use with industrial applications planned. Unibal construction increases strength and durability. Solid inner, outer raceways, deep unbroken grooves with maximum number of balls. Variety of sizes in standard and special types.

Circle number 260 on reader service card

Booth 1339—*Square D Co., Milwaukee, Wis.*

Adjustable-voltage drives

Packaged drives for wide range of operations. Electronic drives give close speed regulation through use of regulating circuit controlling torque, assuring constant speed. Controlled acceleration and dynamic braking. Tube life increased by filament voltage adjustment and time delay relays. Fractional hp units from 1/20 to ¾ hp. Integral hp units to 4 hp, high-performance units to 40 hp.

Circle number 261 on reader service card

Booth 1205—*Delco Products, Div. of General Motors Corp., Dayton, Ohio.*

Polyphase motors

Open drip-proof, totally enclosed nonventilated, explosion-proof and totally enclosed fan-cooled styles. Separately-designed models for normal starting conditions and for high-torque starting. Variety of modifications for electrical (2 or 3 phase, 110 to 550 volts) and mechanical applications. Hp ranges from ¼ to 150.

Circle number 262 on reader service card

Booth 1329, 1333—*Torrington Co., Torrington, Conn.*

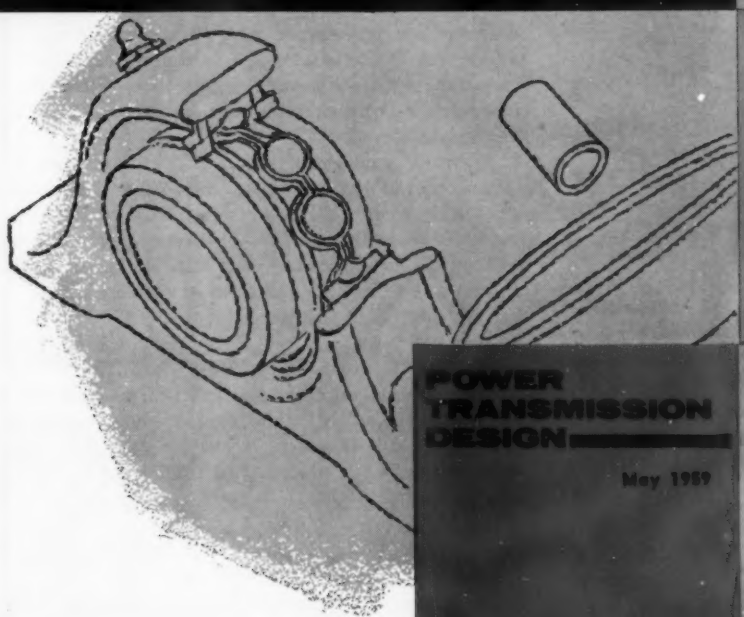
Anti-friction bearings

Heavy-duty roller bearings, interchangeable with HD needle thrust styles. Also, self-aligning ball bushings for linkage and lever applications. DC roller bearings and needle thrust bearings with plastic retainers.

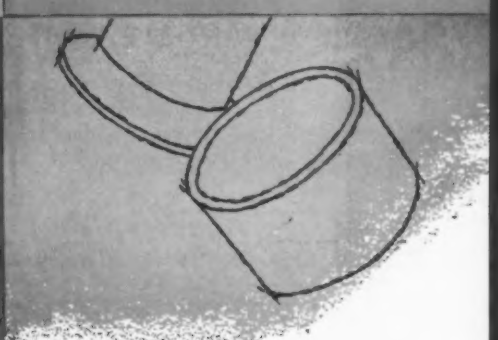
Circle number 263 on reader service card

BEARINGS

DESIGN/APPLICATION

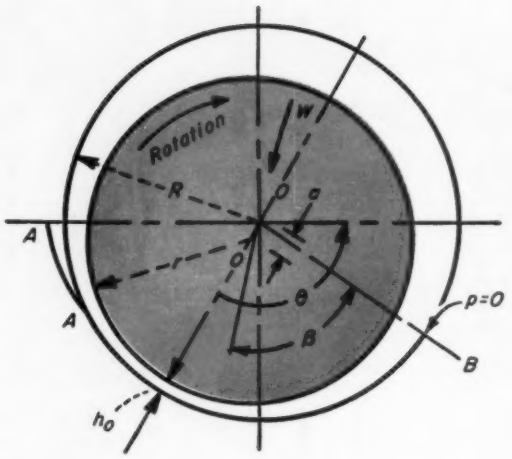


REGULAR MONTHLY SECTION OF IDEAS AND DEVELOPMENTS



POWER TRANSMISSION DESIGN

May 1959



here are the pros and cons of . . .

Air-lubricated journal bearings

THE METHOD OF COMPUTING eccentricity-ratio and film thickness for air-lubricated journal bearings is virtually the same as used in bearings using incompressible lubricants—such as oil or grease. This is true even though air is a compressible gas because the maximum load-carrying capacity for an air-lubricated bearing, when operating under hydrodynamic conditions, is generally a few psi up to a maximum of ten psi. Since this is relatively low, and volume depends upon absolute pressure, the relative change in volume for a gas is not large.

Advantages of Air Lubrication

1. Air as a lubricant is always available.
2. Absence of contamination. If air is substituted for oil or grease, the danger of dripping, soiling, or contamination is completely eliminated. This is important in food processing machinery, thread and textile machines, and in chemical industries.
3. Low friction. Whether the bearing is turning at low speed supported by hydrostatic air pressure, or whether the bearing is turning at high speeds upwards of 100,000 rpm and lubricating itself hydrodynamically, friction is phenomenally low.
4. High-temperature applications. As is typical of gases, the viscosity of air increases with temperature. This is important for bearings operated at elevated temperatures. In the regions of 1000 F and higher, air as a lubricant seems promising.

THIS ARTICLE adapted from Theory and Practice of Lubrication for Engineers by Dudley D. Fuller; published by John Wiley and Sons, Inc., N. Y.

Disadvantages of Air Lubrication

1. Low load-carrying capacity. When an air-lubricated bearing is developing its load-carrying film hydrodynamically, the maximum average load capacity will probably never exceed 15 lb per sq in. even at high speeds. For more normal applications, 5 to 10 lb per sq in. might be a more acceptable maximum. Where the film is supported by the air under pressure (hydrostatic lubrication) there is no limit to the load-carrying capacity. Since compressed air is available in many plants up to about one hundred pounds per square inch, this figure might be a practical limitation for the load-carrying capacity. However, if the need could justify the expense, there is no reason why supply pressures could not exceed this figure.
2. Accurate geometry and surface finish are required. Air-lubricating films are thinner than oil-lubricating films. Surface finishes from 5 to 15 microinches, rms, are required. However, a number of commercial applications have already been made, and no great difficulty has been encountered in holding the machining tolerances.
3. Bearings under certain circumstances exhibit instability in the form of whirl and whip. These phenomena are not uncommon in all bearings but since air has low viscosity, they appear more frequently in air-lubricated bearings. Means for providing more stable bearings can probably be handled by modification of bearing design.

High Speed

The advantages outweigh the disadvantages. These bearings are presently used over wide ranges of

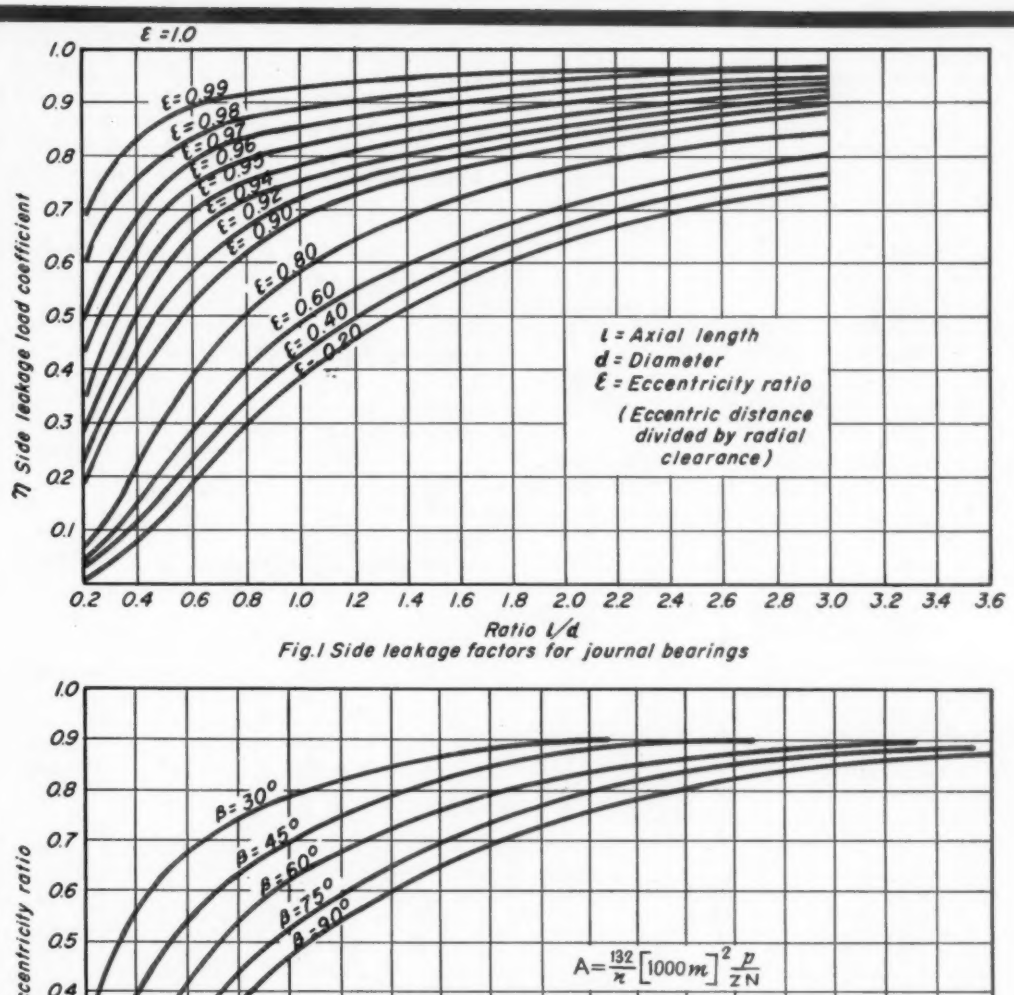


Fig.1 Side leakage factors for journal bearings

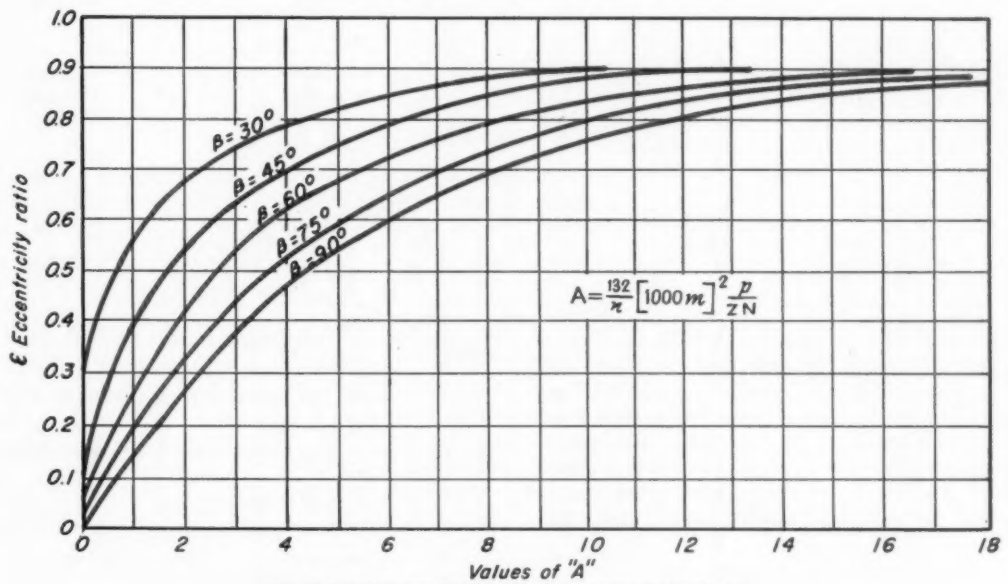


Fig.2 Load-carrying factor for journal bearings

speeds from very low to as high as 100,000 to 150,000 rpm. They have been designed as both journal and thrust bearings and have been lubricated hydrodynamically or by hydrostatic introduction at elevated pressures. A considerable variety of designs is available to produce low friction with good load-carrying capacities. One design of an air-lubricated journal bearing has been used to measure pressure differences as small as 0.01 mm of water.

Example 1

Consider a journal bearing 3½ in. in diameter by 4 in. long with an applied load of 60 lb and a speed of 6000 rpm. The diametral clearance is 0.003 in. Viscosity of air at room temperature, 0.018 centipoises; l/d ratio, 1.14.

Continued on next page

$$p_{avg} = \frac{W}{2rl} \quad \text{.....(1)}$$

$$p_{avg} = \frac{60}{4 \times 3.5} = 4.29 \text{ psi}$$

$$\beta = 90°$$

$$\frac{l}{d} = \frac{4}{3.5} = 1.14$$

$$m = \frac{\text{Diametral clearance}}{\text{Diameter}}$$

$$m = \frac{0.003}{3.5} = 0.000857$$

Assume $\epsilon = 0.6$. Then from Fig. 2, $\eta = 0.57$

$$A = \frac{132}{\eta} [1000m]^2 \frac{p_{avg}}{zN} \quad \text{.....(2)}$$

$$A = \frac{132}{0.57} [1000 \times 0.000857]^2 \frac{4.29}{0.018 \times 6000}$$

$$A = 6.75$$

In Fig. 1, for $A = 6.75$ $\beta = 90°$, find $\epsilon = 0.68$.
Repeating the process, assuming $\epsilon = 0.67$, $\eta = 0.60$, $A = 6.45$
From Fig. 1 for $A = 6.45$, $\beta = 90°$, $\epsilon = 0.67$ which checks. Then the minimum film thickness is

$$h_o = mr\,[1 - \epsilon] \quad \text{.....(3)}$$

$$h_0 = 0.0015[1 - 0.67]$$

$$h_0 = 0.0005 \text{ in.}$$

The minimum film thickness is 0.0005 in. Experimentally the measured film thickness for this bearing would be close to this. A deviation of 10 to 15 per cent may be considered reasonable. The surface finish is ten microinches, rms. As a general consideration, the minimum film thickness for any well-designed bearing, including air bearings with good surface finish and geometry, should not be less than 0.0001 in.

Friction torque may be computed by

$$M_J = \frac{\mu l r^2 N}{m} \times K_{fJ} \quad \text{.....(4)}$$

or, if the applied load is light, friction torque may be calculated by

$$M = \mu A r \frac{v}{h} \quad \text{.....(5)}$$

or

$$M = \frac{\pi}{4} \frac{\mu \omega l d^3}{h} \quad \text{.....(6)}$$

Example 2

A bearing 3 in. in diameter by 4 in. long running in atmospheric air at a speed of 1800 rpm and with a diametral clearance of 0.002 in. would have a friction torque as indicated by the last equation above. Viscosity of air at atmospheric conditions = 0.018 centipoise or 1.45 x 0.018 x 10^{-7} lb sec/in.^{2} (reyns).

$$M = \frac{2\pi (1.5^3)(4)(1.45)(0.018)(10^{-7})(\frac{1800}{60} \times 2\pi)}{0.001}$$

$$\text{or Friction horsepower} = \frac{2\pi MN}{12 \times 33{,}000}$$

$$= \frac{2\pi \times 0.042 \times 1800}{12 \times 33{,}000}$$

$$= \frac{1}{840} \text{hp}$$

An evaluation of the Reynolds number for the air film in this bearing would show

$$R = \frac{VD}{\nu} = \frac{\frac{1800}{60} \times \pi \times 3 \times 0.001}{0.0232} = 12.2$$

where the kinematic viscosity of air at atmospheric conditions is 0.0232 in.^{2}/sec. $R = 12.2$, much less than 2000.

Nomenclature

$A = \frac{132}{\eta} [1000\,m]^2 \frac{P}{zN}$

K_{fj} = friction factor, journal or shaft
M = friction moment, in-lb
M_j = friction moment, journal or shaft, in-lb
N = speed, rpm
P_{avg} = average pressure based on projected area, psi
R = Reynolds number
d = shaft diameter, in.
h_o = minimum film thickness, inches
l = length of bearing, in.
m = clearance modulus, diametral clearance/diameter
r = radius of shaft, in.
v = linear surface velocity, in./sec
β = bearing angle
η = side flow coefficient
ϵ = eccentricity ratio = $1 - h_o/mr$
z = absolute viscosity in centipoises
μ = absolute viscosity in Reyns
ν = kinematic viscosity
ω = angular velocity, radians/sec

U.S. Rubber changes

Several changes have been made in the branch sales departments of United States Rubber Co.'s Mechanical Goods Div. E. G. Morrill, formerly district sales manager at the Denver branch replaced Donald L. Reid as district sales manager at the Los Angeles branch. Reid was recently named regional sales manager, West Coast branches. W. E. Larson, replace Morrill as district sales manager at Denver; he was formerly at Minneapolis. Carl A. Driesch succeeds Larson at Denver; he had been Assistant at Pittsburgh. The company's lines include power transmission products, conveyor belting and packing.

Formsprag appointments

Robert E. Hoelscher has been named sales engineer for the Formsprag Co., Warren, Mich. Operating from the Dayton office, he will cover Kentucky, southern Indiana, and southern Ohio. Before joining Formsprag, he was an application engineer on the sales staff of the Square D Co.

The company has also announced the appointment of James McGraw, Inc., of Richmond, Va., as distributor of Formsprag and Rawson clutches. McGraw's territory will be the entire state of Virginia.

Chief Kolcast Engineer

Harold D. Blake has been named chief engineer, Kolcast Industries, a division of Thompson Products, Inc.

Groves, Dana Metallurgy Chief

Wilson T. Groves has been appointed chief metallurgical engineer, Dana Corp.

New Directors elected to PMPMA board

The Powder Metallurgy Parts Mfgrs. Assn. has named the following new members to its board of directors: P. J. Failla, Johnson Bronze Co.; W. L. Strawbridge, Sr., Precision Metal Products Co.; and R. L. Pettibone, Eaton Mfg. Co.

ASME gives national awards

American Society of Mechanical Engineers announces the following recipients of national awards: Allison K. Simons, Bostrom Research Laboratories—Pi Tau Sigma Gold Medal; Wilfred Fishwick, University College of Swansea, and S. A. Tobias, Cambridge University, England—Blackall Machine Tool and Gage Award; Harold J. Rose, Bituminous Coal Research, Inc.—Worcester Reed Warner Medal; Thomas P. Goodman, General Electric Co.—Melville Medal; and Theodore von Karman, NATO Advisory Group for Aeronautical Research and Development, Arpad L. Nadai, formerly with Westinghouse Research Laboratories, and Sir Geoffrey Ingram Taylor, former Yarrow Research Professor of the Royal Society—Timoshenko Medal.

Owns Marion Electrical

Minneapolis-Honeywell Regulator Co. has purchased Marion Electrical Instrument Co., Manchester, N. H.

BJ Electronics has new vp

Dr. John H. Buck is newly appointed vice president of engineering, BJ Electronics, Borg-Warner Corp.

Eaton Mfg. makes Mitchell plant manager at Dynamatic

Robert E. Mitchell is appointed plant manager of the Dynamatic Division, Eaton Mfg. Co., Kenosha, Wis. He is a former member of the company's central industrial relations staff in Cleveland.

Bergstrom president at Cincinnati Milling

Swan E. Bergstrom is the newly elected president, and Robert C. Bevis, a vice president, of Cincinnati Milling and Grinding Machines, Inc., sales subsidiary of the Cincinnati Milling Machine Co.

Mr. Bergstrom, who succeeds F. V. Geier, is president of the parent firm. Geier is retired.

Bevis is sales manager of the sales subsidiary.

Anderson to head Marion Electrical

Carl A. Anderson, former vice-president in charge of the Minneapolis-Honeywell Regulator Co.'s Aeronautical Division in Canada, has been named general manager of the company's recently acquired Marion Electrical Instrtument Co., Manchester, N. H.

Demrick is now Amplex president

Carl J. Demrick is new president of Chrysler Corporation's Amplex Division. Amplex, with headquarters at 6501 Harper Ave., Detroit, Mich., is a producer of powdered metal products.

Clark Controller promotes Bundy

O. M. Bundy is newly named manager of the New Products Division of Clark Controller Co., Cleveland, Ohio, manufacturer of electrical control devices, components, and systems. The new position is in addition to his present duties as director of research.

AIREE award 'fellow' honors

American Institute of Electrical Engineers has awarded the honor of Fellow to its following members: Carl H. Bjorquist, Bonneville Power Administration; Theodore W. Stringfield, Bonneville Power Administration; Albert Hansen, Jr., Donnell D. MacCarthy, C. Russell Mason and Myron S. Wilson, General Electric Co.; William C. White, Northeastern University; Robert R. Wagstaff, United Engineers Constructors, Inc.

Vickers has new mgr in California office

Jack Newlove is promoted to district manager of the El Segundo, Calif., office of Vickers Incorporated, a division of Sperry Rand Corporation. Newlove was formerly an application engineer at the Detroit office. He is a member of the Society of Automotive Engineers and the Engineering Society of Detroit.

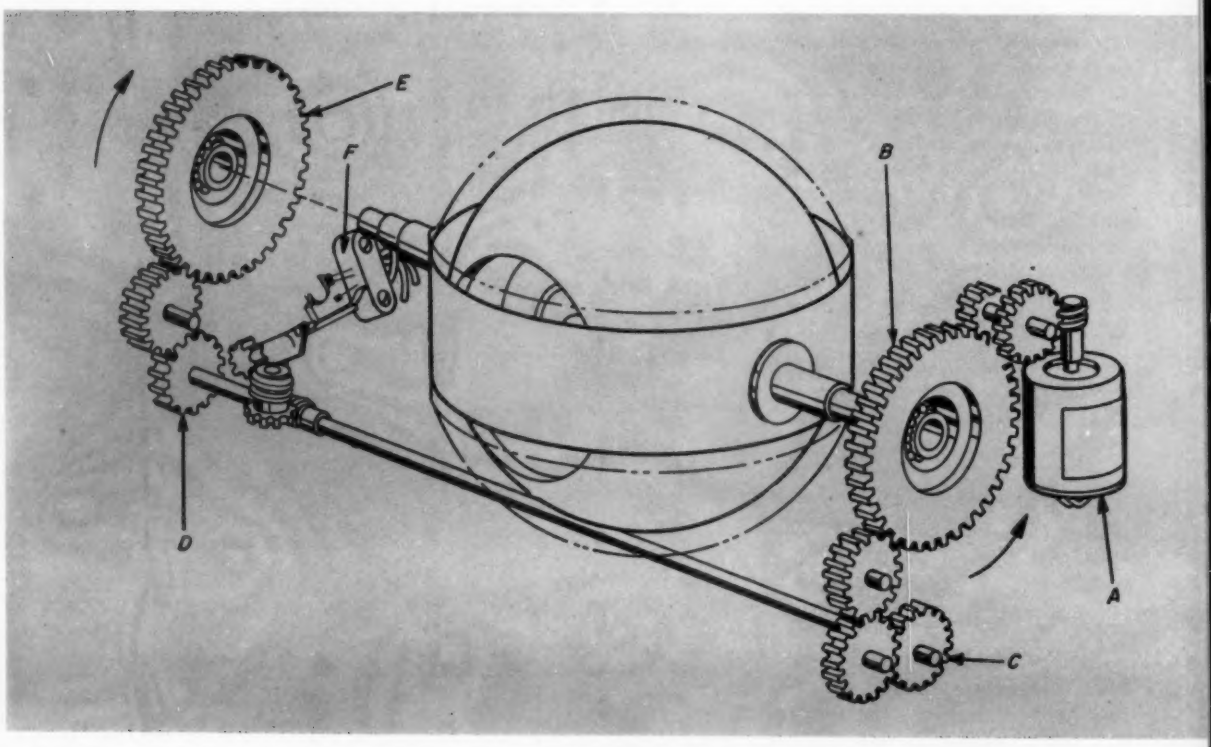
Driven races reduce bearing friction

SMALL MOTOR AND GEARS, built into a directional gyroscope, greatly reduce random drift, or precession, caused by bearing friction torque. This principle, when applied to nonfloated gyros, reduces random drift by 1200% from 3 or more deg/hr to about ¼ deg/hr. In laboratory tests random drift has been reduced to 1/20 deg/hr or better.

In a typical gyro using the system, a small motor drives the outer races of the gimbal bearings. The two outer races turn in opposite directions through a predetermined number of revolutions. The motor is then reversed to drive the bearing races at the same speed through the same number of revolutions in the opposite direction. This averages out the errors. Speed and number of revolutions, through which the bearings are driven, is determined for each application by bearing size and the gyro constants.

In addition to compensating for bearing friction, the system averages out the errors caused by minute irregularities found in the most precise ball bearings, and prevents pitting and wear of certain balls or spots on the races. Differences between the two bearings are also cancelled out by the system.

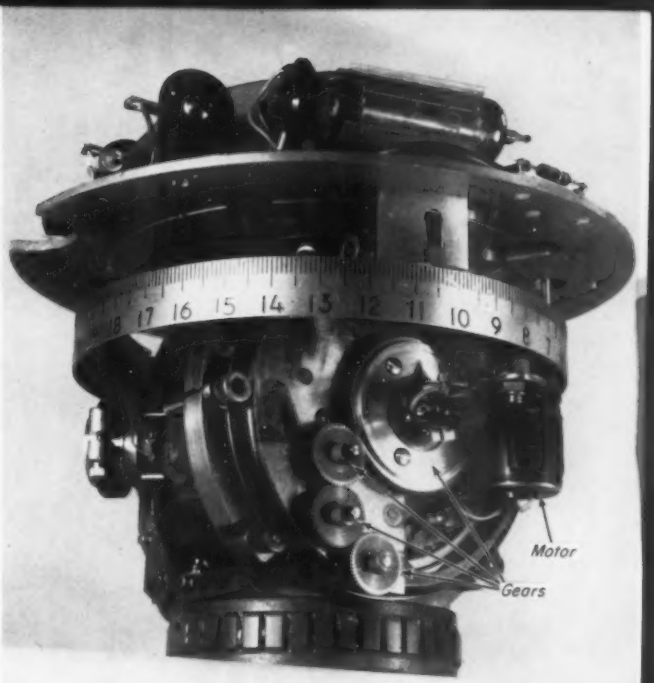
The small electric motor and the gear train are an



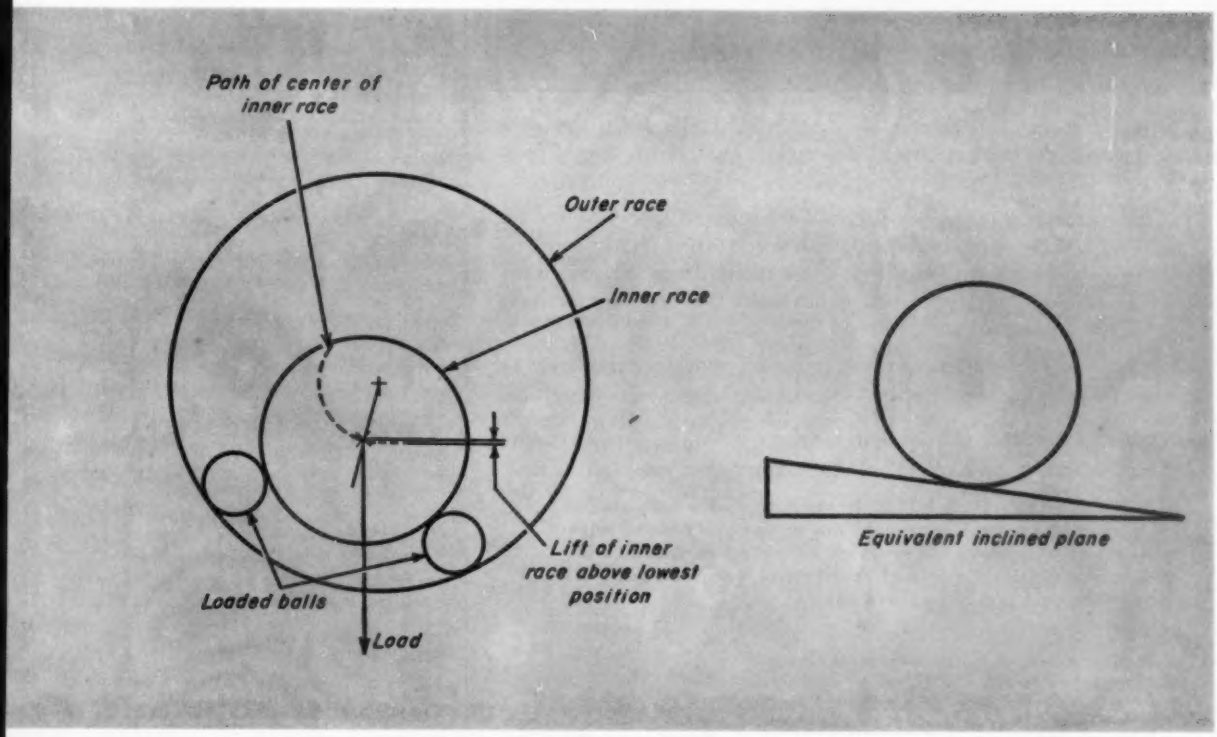
BEARING-RACE DRIVE consists of a small motor, *A*, which drives gear *B* to rotate the outer race of one gimbal bearing. Power is then transmitted through gears *C* and *D* to drive gear *E* to rotate the other gimbal bearing in the opposite direction. Mechanism *F* reverses the drive motor at predetermined intervals.

integral part of the gyro unit. The gyro unit is part of a guidance package which has been used to help guide the submarines Nautilus and Skate in their polar crossings. They are now in use aboard DC-7C aircraft flying polar routes and are also in volume production for use in the Douglas DC-8 and Boeing 707 jet airliners. Use in guidance systems for missiles is also being considered.

Both the frictionless gyro and the guidance system are developments of *Sperry Gyroscope Co., Div. of Sperry Rand Corp.*, Great Neck, N. Y.

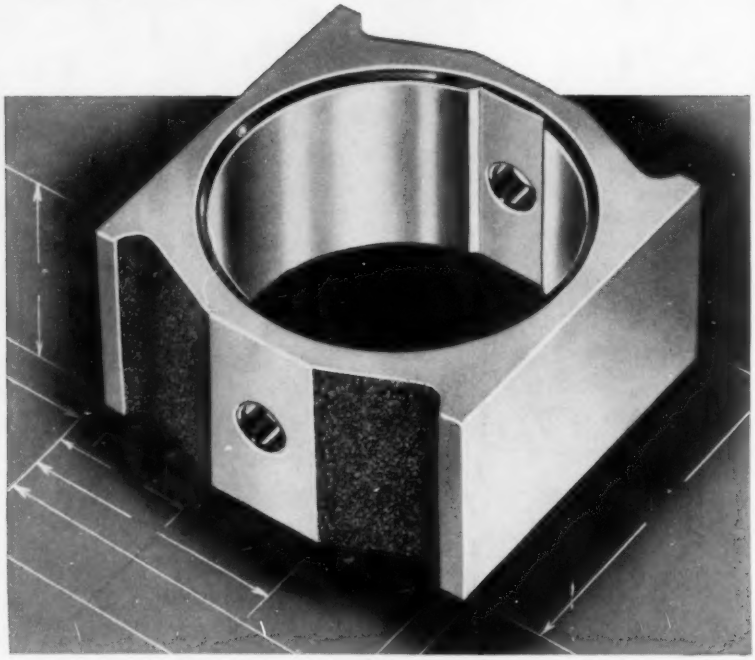


LOW RANDOM DRIFT GYRO includes bearing race drive. Motor and a portion of the gear train are visible in this photo.



ONE FORM OF TORQUE present in all ball bearings results from inner race riding up and down as the weight on the bearing moves from one ball to another. This purposely exaggerated sketch of a bearing shows how this happens. This movement is equivalent to movement along the inclined plane shown at right.

many difficult requirements...



We illustrate the cast bronze cam block for a hydraulic pump operating the hydraulic lift mechanism on an exceedingly well-known line of farm tractors.

The manufacturer of this equipment has very unusual specifications for this cam block. Its bore has a very fine finish specification. It also must be round and true to size within unusually close limits. In addition, it must be square to the face of the cam block within limits that ordinary methods of manufacture will not attain.

Bunting methods of manufacture result in a part which is completely to the customer's exacting specifications.

For the unusual, as well as the usual, in bearings, bushings, bars, or special parts of cast bronze, sintered metal, or Alcoa aluminum, see Bunting first.

BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.

...ask or write for your copy of...

Bunting's "Engineering Handbook on Powder Metallurgy" and Catalog No. 58 listing 2227 sizes of completely finished cast bronze and sintered oil-filled bronze bearings available from stock.

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For more information circle No. 7 on the Reader Service Card

MEETINGS

MAY 18-20

Instrument Society of America, 5th annual symposium on instrumental methods of analysis, Shamrock-Hilton Hotel, Houston, Tex. Contact: Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

MAY 19-23

American Foundrymen's Society, 62nd foundry show and castings congress, Cleveland, Ohio.

MAY 20-22

Society for Experimental Stress Analysis, spring meeting, Sheraton Park Hotel, Washington, D. C. Contact: R. O. Belsheim, 2475 Virginia Ave., N. W., Apt. 514, Washington 7, D. C.

MAY 21-22

American Institute of Mining, Metallurgical, and Petroleum Engineers, 13th New England Regional Conference, Statler Hotel, Hartford, Conn.

MAY 25-28

American Society of Mechanical Engineers, Machine Design Div., design engineering conference and show, Convention Hall, Philadelphia, Pa. Contact: Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

MAY 26-28

Anti-Friction Bearing Manufacturers Association, annual meeting, Drake Hotel, Chicago, Ill. Contact: H. O. Smith, secretary-manager, 60 E. 42nd St., New York, N. Y.

MAY 31-JUNE 3

American Gear Manufacturers Association, annual meeting, The Homestead, Hot Springs, Va. Contact: J. C. Sears, executive director, 1 Thomas Circle, Washington 5, D. C.

JUNE 14-18

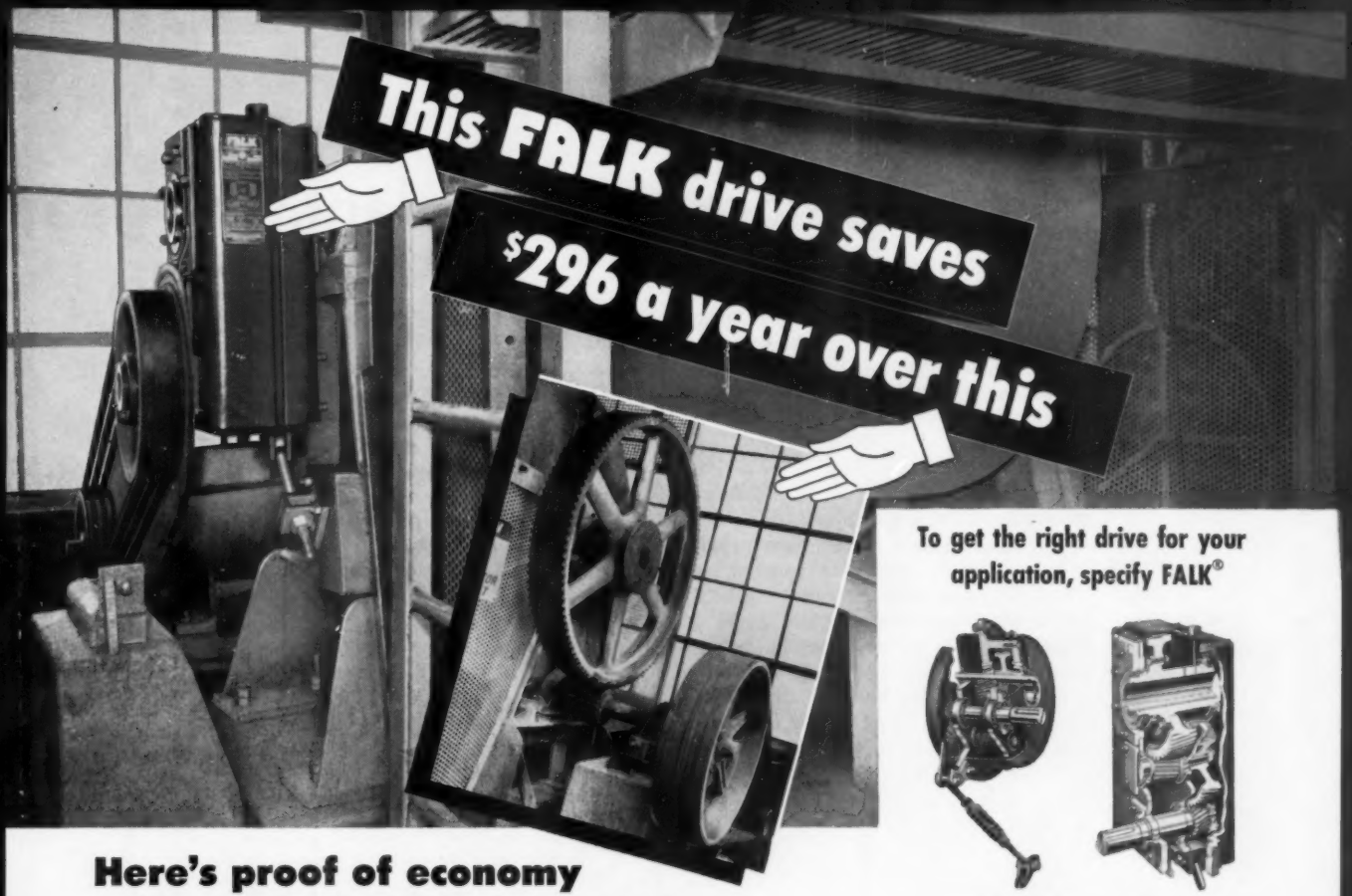
American Society of Mechanical Engineers, semi-annual meeting, Chase-Park Plaza Hotel, St. Louis, Mo.

JUNE 14-19

Society of Automotive Engineers, summer meeting, Chalfonte-Haddon Hall, Atlantic City, N. J. Contact: Robert W. Crary, public relations manager, SAE, 485 Lexington Ave., New York 17, N. Y.

JUNE 18-20

American Society of Mechanical Engineers, applied mechanics conference, Virginia Polytechnic Institute, Blacksburg, Va.



Here's proof of economy with FALK Shaft Mounted Drives

PROBLEM—For many years, a prominent Eastern abrasives manufacturer* experienced high maintenance and down-time costs, as well as excessive noise and vibration, in the operation of 19 pebble mills driven by open spur gears. Drive gears and jack shaft pillow blocks required frequent repairs or replacement, and trunnion shafts often failed, due to radial overloading of the bull gear when broken pinion teeth bottomed between gear teeth.

SOLUTION—After numerous unsuccessful approaches to these problems, the solution was found by mounting a Size 315J FALK Shaft Mounted Drive directly on the mill drive trunnion. This eliminated objectionable gear noise and vibration...greatly reduced costly down-time and loss of production...and cut annual maintenance and replacement expenses as indicated by the following figures taken from the customer's records:

Spur Gear-and-Pinion Drive		FALK Shaft Mounted Drive	
Bull Gears	$ 56	VEE Belts	$ 30
Pinions	120	FALK Shaft Mounted Drive (based on 10-year life)	70
Pillow Blocks	90		
VEE Belts	30		
Trunnion (5-year life)	100		
Annual cost	$396	Annual cost	$100
		ANNUAL SAVINGS	$296

IF OBSOLETE DRIVES ARE COSTING YOU MONEY, a change to Falk All-Steel Shaft Mounted Drives can effect important savings in money and production. Used on almost any type of machine, these compact, rugged units are establishing new standards of economy and efficiency in many industries. Specify FALK Drives on your purchased equipment...For full details, **write for Bulletin 7100.**

*Name on request

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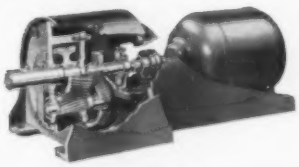
SHAFT MOUNTED DRIVES

Horizontal or vertical units—½ to 50 hp—420 to 5 rpm—single and two double reduction ratios—output torque ratings up to 41,000 lb-in (consult factory for higher torque capacity).

• • •



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Sizes up to 75 hp—furnished with or without standard foot-mounted motor—standard output speeds 1.2 to 520 rpm (with 1750 rpm motors)—ratios as high as 54,000:1 in semi-standard designs. Integral units (gearmotor type) also available. Ask for **Bulletin 3100.**

• • •

FALK Drives are available from factory and distributor stocks from coast to coast. Consult your Falk Representative or Distributor.

FALK

...a good name in industry

Nomograms for planetary gear

PLANETARY GEAR SPEEDS

ANGULAR SPEEDS of sun gear, planet carrier, and ring gear in a planetary gear train of the type shown in the small sketch with Nomogram A are related by

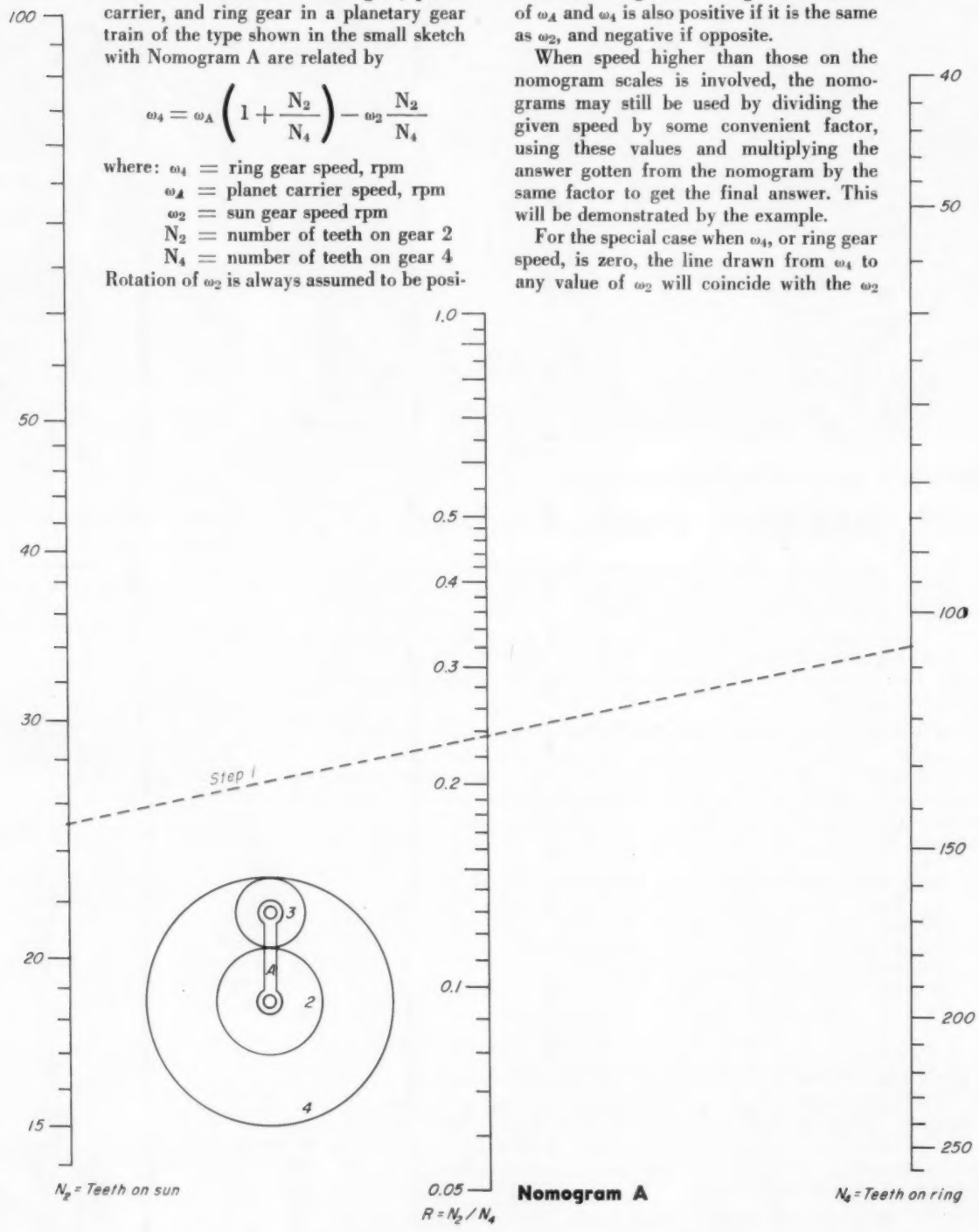
$$\omega_4 = \omega_A \left(1 + \frac{N_2}{N_4}\right) - \omega_2 \frac{N_2}{N_4}$$

where: ω_4 = ring gear speed, rpm
ω_A = planet carrier speed, rpm
ω_2 = sun gear speed rpm
N_2 = number of teeth on gear 2
N_4 = number of teeth on gear 4

Rotation of ω_2 is always assumed to be positive when using these nomograms. Rotation of ω_A and ω_4 is also positive if it is the same as ω_2, and negative if opposite.

When speed higher than those on the nomogram scales is involved, the nomograms may still be used by dividing the given speed by some convenient factor, using these values and multiplying the answer gotten from the nomogram by the same factor to get the final answer. This will be demonstrated by the example.

For the special case when ω_4, or ring gear speed, is zero, the line drawn from ω_4 to any value of ω_2 will coincide with the ω_2



Nomogram A

speed and number of teeth

By J. N. ARNOLD, *professor, and* ALLAN C. DUNK, *assistant professor, Purdue University*

scale. This does not affect the procedure. There may also be times when lines drawn to solve a problem will coincide with each other. Again, this does not affect the method.

EXAMPLE: Let $N_2 = 25$, $N_3 = 40$, $N_4 = 105$, $\omega_A = 15{,}000$ rpm—counterclockwise, and $\omega_2 = 40{,}000$ rpm—counterclockwise. Find ω_4.

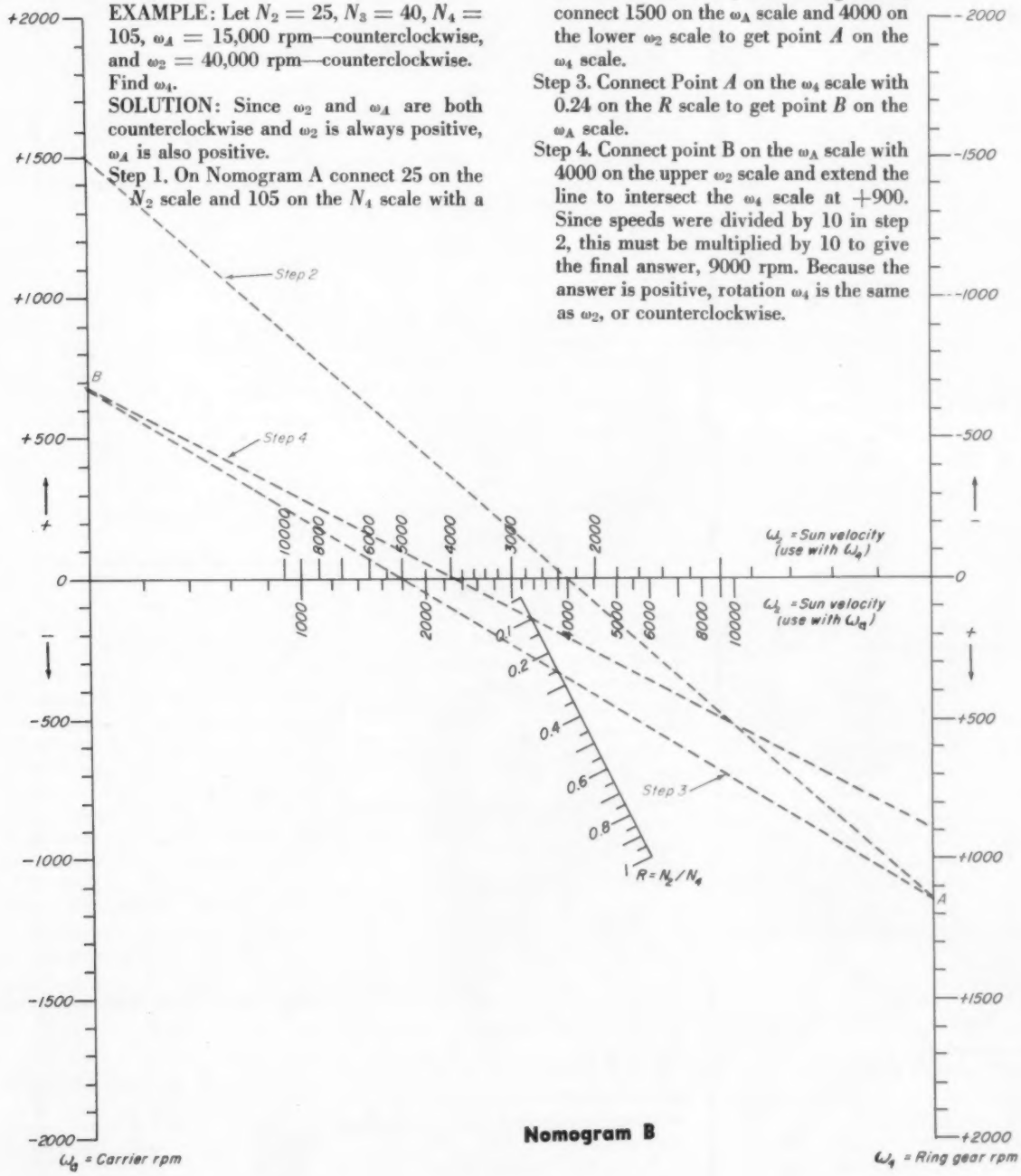
SOLUTION: Since ω_2 and ω_A are both counterclockwise and ω_2 is always positive, ω_A is also positive.

Step 1. On Nomogram A connect 25 on the N_2 scale and 105 on the N_4 scale with a straight line and read $N_2/N_4 = 0.24$ on the R scale.

Step 2. First divide ω_A and ω_2 by 10 to give values of 1500 and 4000 rpm which are on the scales. Then, on Nomogram B, connect 1500 on the ω_A scale and 4000 on the lower ω_2 scale to get point A on the ω_4 scale.

Step 3. Connect Point A on the ω_4 scale with 0.24 on the R scale to get point B on the ω_A scale.

Step 4. Connect point B on the ω_A scale with 4000 on the upper ω_2 scale and extend the line to intersect the ω_4 scale at $+900$. Since speeds were divided by 10 in step 2, this must be multiplied by 10 to give the final answer, 9000 rpm. Because the answer is positive, rotation ω_4 is the same as ω_2, or counterclockwise.



Nomogram B

LITERATURE *on drives and components*

AC adjustable drive

Ajusto-Spede is a standard alternating current squirrel cage motor with an integral current clutch. It's a compact, efficient variable speed drive, controllable by temperature, humidity or pressure control elements, or by multiple control stations. Manufacturer claims efficiencies of 85-90 percent for the motor and 95-97 percent for the clutch, for an overall efficiency of 81-87 percent at top speed. Illustrated Bulletin 611 E includes operating curves, photos of components and typical application, and list of distributors. 16 pages.

The Louis Allis Co., Milwaukee, Wis.

Circle number 100 on reader service card

Precision stock gears

Complete line of fine-pitch precision gears that are available immediately from stock is described in 96-page catalog. Information, including dimensions and prices, covers gears from 48 through 200 pitch, to AGMA Precision Classes 1 and 2.

U. S. Gear Corporation, Wakefield, Mass.

Circle number 101 on reader service card

Tracer control

How tracer control system works for a wide variety of metalworking applications is described in 8-page Bulletin GEA-6122. Numerical positioning and numerical contouring controls are also discussed.

General Electric Co., Specialty Control Dept., Waynesboro, Va.

Circle number 102 on reader service card

Speed reducer

Four-page engineering bulletin gives dimensions and ratings of mechanical speed reducers with helical or herringbone gears, most of them available immediately from stock.

Alten Foundry and Machine Works, Inc., Lancaster, Ohio.

Circle number 103 on reader service card

Universal joints

Ten-page catalog covers line of single and double universal joints, including specifications and prices. It also includes instructions for disassembly, reassembly and lubrication; hints for selecting proper universal joints; conversion table relating static torque in.-lb to hp at 100 rpm; and key seats, setscrews and broaches that are available.

Curtis Universal Joint Co., Inc., Springfield, Mass.

Circle number 104 on reader service card

DC motor

Model D-1000 is a 1.6-hp 28-v dc motor, with a normal operating range from 0.6 to 1.8 hp. It's designed to operate continuously at 260 F at 60,000 ft. Bulletin gives performance curve and mounting dimensions.

Hoover Electric Co., Columbus, Ohio.

Circle number 105 on reader service card

Thermoplastic for bushings

Ultra-Ethylux thermoplastic has been used for bushings and similar purposes. Brochure W-200 incorporates a selector guide giving the properties of Ultra-Ethylux and five other thermoplastics.

Westlake Plastics Co., Alphalux Div., Lenni Mills, Pa.

Circle number 106 on reader service card

Dual-range transmission

Hystamatic transmission for trucks is a hydraulically-shifted, constant-mesh unit with integral torque converter. Its two speed ranges forward and reverse are selected by the operator by means of levers. All components are in a single housing mounted to the engine as an integral part of the power train. Four-page brochure covers design and performance features.

Hyster Co., Portland, Ore.

Circle number 107 on reader service card

Helical gear motors

Construction features and applications of helical gear motors and speed reducers are described and illustrated in four-color, 16-page Bulletin GEA-6704. Cutaways show maintenance features. Information is provided on field and factory testing help.

General Electric Co., Gear Motor and Transmission Components Dept., Paterson, N. J.

Circle number 108 on reader service card

400-cycle motor

Bulletin gives dimensions and performance curve for Model C-2610 1-hp 400-cycle ac motor designed for applications requiring a lightweight (2.6 lb) power unit in aircraft, ordnance, missile, marine and industrial applications. Construction is explosion-proof, to Military Specification E-5272A.

Hoover Electric Co., Columbus, Ohio.

Circle number 109 on reader service card

Engineering progress

Latest edition of "Engineering in Action," Allis-Chalmers' annual review of progress and achievements, is attractive 36-page magazine covering all phases of the company's Industries Divisions. Chapters cover research, power generation, nuclear power, electrical power transmission and distribution, metals and mining, chemicals and petroleum, general industry, government and marine, plant facilities, and foreign operations.

Allis-Chalmers Manufacturing Co., Industries Group, Milwaukee, Wis.

Circle number 110 on reader service card

FACTS AT YOUR FINGERTIPS

Your source for copies of any item mentioned in these pages is as close as the Reader Service Cards bound into this issue. Fill them out and mail: no postage needed.

Belt conveyors

New 88-page catalog shows principal belt conveyor products manufactured by company, including heavy-duty and standard roller bearing and precision ball bearing idlers. Comprehensive engineering data section contains simplified and condensed information for selection of belt conveyors and related equipment. Catalog ID-591.

Continental Gin Co., Industrial Div., Materials Handling Dept., Birmingham, Ala.

Circle number 111 on reader service card

Triple synchro-resolver

Data sheet 117-8 describes the Model 2010C resolver, which consists of three electrically isolated resolver elements having a common rotor shaft. In a servo system, this unit could be used to control three different circuits from a common servo drive.

Lear, Inc., Grand Rapids Div., Grand Rapids, Mich.

Circle number 112 on reader service card

Selsyns and synchros

Highly accurate selsyns and synchros will transmit electric angular data between two or more points with an accuracy of plus or minus 0.3 to 1.5 degrees, depending on the model. Sixteen-page Bulletin GEA-6675 discusses selsyn and synchro generators, motors, control transformers, differential generators, differential motors, tandem selsyns, and system operation; it also includes schematics, figures, tables, charts and dimensions.

General Electric Co., Specialty Motor Dept., Fort Wayne, Ind.

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Magnetic drives

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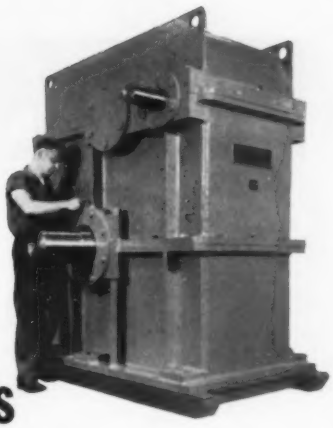

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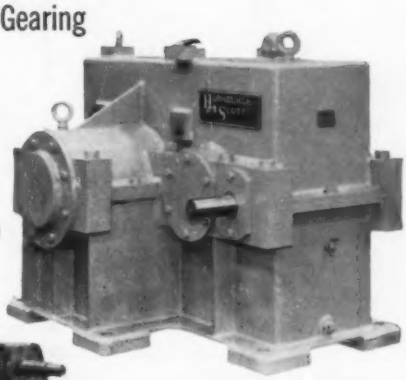

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Gas turbine auxiliary power demand is increasing

By PAUL G. STEIN, *assistant project engineer, AiResearch Mfg. Co. of Arizona Div. Garrett Corp.*

AUXILIARY POWER required for modern, turbine-powered aircraft is so high that it must be provided for very early in design. Auxiliary power is all the power required for every use but propulsion. This includes electric, hydraulic, and pneumatic power used before, during and after flight. Auxiliary gas turbines have come into wide use as prime movers since 1950.

Among early uses was an alternator drive where weight of the turbine was quite a bit less than the reciprocating engine used before. Another early application was on a Navy A2D turboprop to give self-contained starting power. The Convair P5Y used a gas turbine for starting main engines and generating electrical power. In this case the gas turbine drove an air compressor. Air from the compressor was used to drive air turbine motors for starting and driving 400-cycle alternators. In the last two years, systems have been used for starting main engines, supplying in-flight power, and supplying compressed air for: pressurization, ventilation, heating and cooling the cabin. Completely integrated systems like this have proved that auxiliary pneumatic power is desirable on both large and small airplanes.

System Comparisons

To get the best auxiliary system, power requirements must first be determined and various possible system compared. Low-pressure pneumatic systems with an air-turbine-driven compressor don't necessarily fit this picture in every respect. Let's discuss some of the merits of such a system.

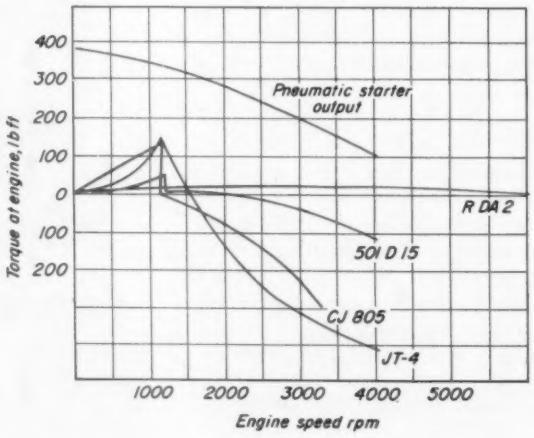
Engine starting: Today's turbine engines are hard to start. Figure 1 shows the torque required vs rpm for starting several. Low-pressure pneumatic starters have been developed to do this. These starters will start the engines in less than 30 sec. Air for the starting turbines may be supplied by an air turbine compressor on the plane, a ground turbine, or by air bottles on the plane. Table 1 compares the weights of these systems. The first two are compared schematically in Figure 2.

Lightest system is that which keeps the turbine on the ground. However, this means that a ground truck is needed at each stop to start the airplane.

In comparing the aircraft-mounted turbine with the bottle system, it is obvious that the turbine offers an unlimited number of starts and can be used for prolonged cranking to check engine controls, blow out fuel accumulated during previous starting attempts, or blow out fires in the tail pipe caused by fuel accumulation.

Reliability of these gas turbine starting systems is shown by the data in Table 2. Systems covered in the table have completely automatic starting cycles which are initiated by momentary-contact electrical push-

FIG. 1. Torque required for starting aircraft turbine engines.



This article is abstracted from a paper presented at the SAE National Aeronautic Meeting, Hotel Commodore, New York, March 31-April 13, 1959.

Table 1—Starting System Weight Comparison

Component	System A* Weight, No.	total (lb)	System B† Weight, No.	total (lb)	System C‡ Weight, No.	total (lb)
Air turbine starter	4	95	4	95	4	95
Starter valve	4	24	4	24	4	24
Air bottle and fittings	—	—	—	—	4	215
High-pressure shutoff valve	—	—	—	—	4	34
Fuel/air combustor	—	—	—	—	4	74
Fuel pumps	—	—	—	—	4	10.2
3000-psi compressor	—	—	—	—	2	38.8
Auxiliary turbine	—	—	1	220	—	—
Air ducts	—	65	—	90	—	79
Fuel lines	—	—	—	20	—	34
Wiring	—	15	—	19	—	35
Brackets, etc.	—	25	—	24	—	79
Fire extinguisher	—	—	—	23	—	—
Insulation	—	—	—	50	—	—
Total weight		224		565		718

**Ground cart system, †Auxiliary turbine on plane.*
‡High-pressure air bottle system.

Table 2—Reliability Statistics for Gas Turbine Starters

A. For ground cart, Typical 30-day period—last half of 1958

Total hours of operation	2,532.5
Number of GTC starts	20,743
Number of units reporting	200
Average starts per unit per month	103.7
Average starts per hour of operation	8.191
Number of operational delays per 100 starts on all units for reasons of mechanical delay and premature removal	0.699
Mean number of starts between malfunctions	1,431

B. For gas turbine compressor aboard Lockheed C-130 aircraft, for December 1958

Total hours of operation	789.4
Number of GTC starts	6,055
Number of units reporting	71
Average starts per unit per month	85.3
Average starts per hour of operation	7.67
Number of operational delays per 1000 starts on all units for reasons of mechanical delay and premature removal	0.826
Mean number of starts between malfunctions	1,211

buttons. This keeps operator skill required to a minimum. Many of the malfunctions indicated in the table can be corrected on the spot. From 1/2 to 2/3 of them can be fixed without removing the unit from service.

Cabin pressurization and conditioning: Lots of air is required for pressurizing and ventilating an aircraft cabin. For instance, a 130 passenger turbojet that recently went into airline service has a ventilation rate of 1.5 lb of air per minute per passenger. This means that for a nine hour New York to Paris flight 105,300 lb of air must be pumped through the cabin. Theoretical horsepower required to provide this air and keep the cabin pressurized to the equivalent of 8000 ft altitude when the plane is at 40,000 ft is 211. Actual horsepower required is almost double.

The power for conditioning and ventilating must come from either the main engines or some auxiliary power unit. Present practice in turbine transports is to bleed air from the main engines to drive air turbines which drive the cabin superchargers. This system has all the elements of a gas turbine but the combustor. Some military transports have used auxiliary gas turbines for cabin supercharging. The Douglas C-133 uses two 220-hp turbines to deliver 76 lb of air per minute to the cabin.

Miscellaneous power: Beside starting and in-flight power, power is required before take-off and at stops. Air for cabin conditioning, and electric and electric and hydraulic power are needed. It is undesirable and uneconomical to keep one of the main engines running to provide these. Gas turbine compressor units have been developed to permit simultaneous extraction of shaft power for driving generators and hydraulic pumps mounted on accessory pads at constant speed. Such a unit is now used on a large turbine-powered transport now entering airline service. If the unit is also used for starting the engines, this added service is obtained with little increase in installed weight. However, the turbine must be designed into the plane early. It can't be fitted in as an afterthought.

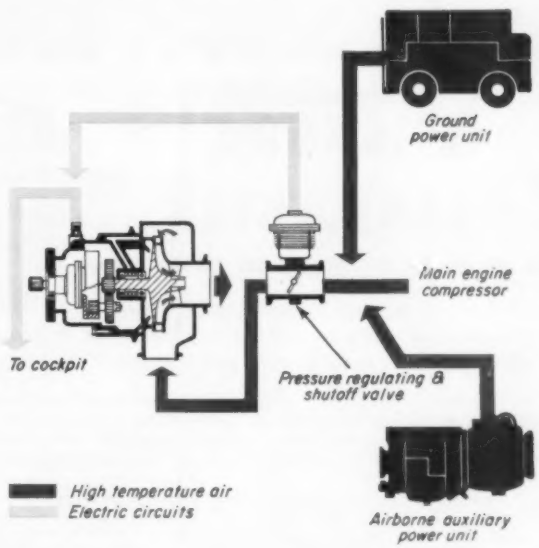


FIG. 2. Airborne and ground-powered gas turbine engine starting systems.

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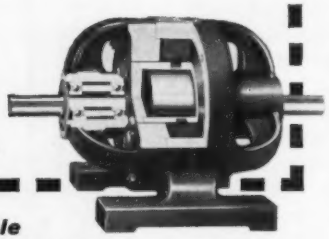

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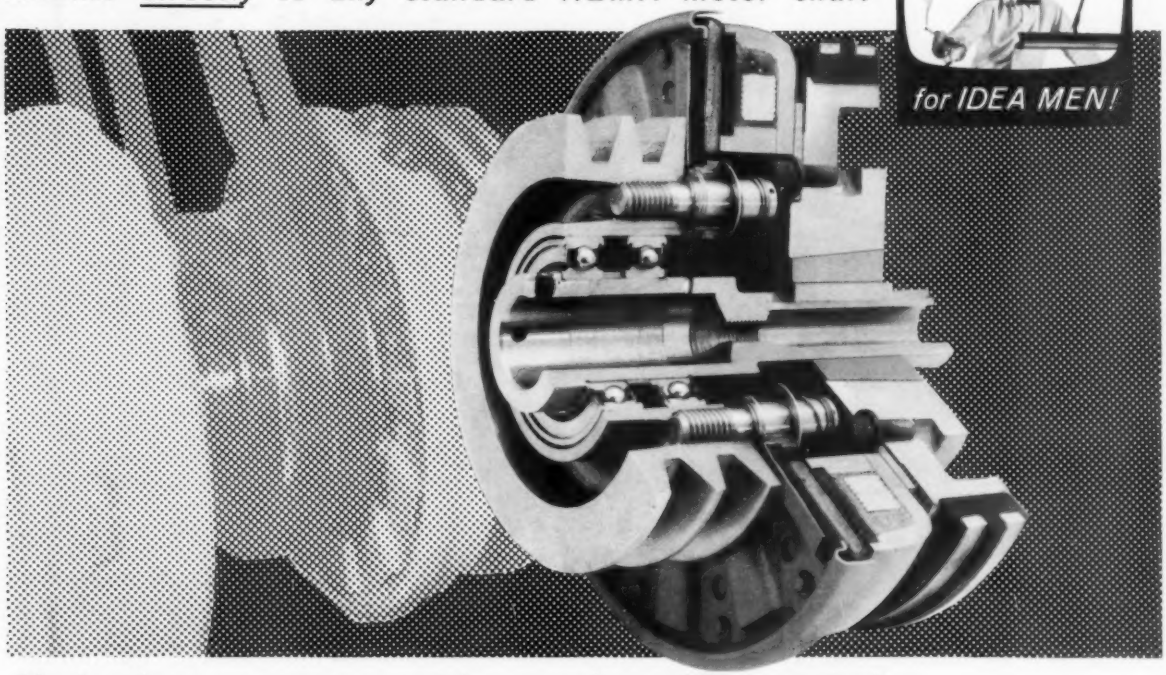

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